

**“STANDARDIZATION OF GRAFTING TIME IN
JAMUN (*Syzygium cumini* L.) UNDER
NORTH MAHARASHTRA CONDITIONS”**

By

Mr. KHETMALAS SURAJ SUDHAKAR
(Reg. No. 011/321)

A Thesis Submitted to the

**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST.AHMEDNAGAR,
MAHARASHTRA, INDIA**

In partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE (HORTICULTURE)

in

FRUIT SCIENCE

**HORTICULTURE SECTION,
COLLEGE OF AGRICULTURE, DHULE-424004
MAHARASHTRA, INDIA**

2013

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Approved by

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**HORTICULTURE SECTION,
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MAHARASHTRA, INDIA
2013**

CANDIDATE'S DECLARATION

*I hereby declare that this thesis or
part thereof has not been
submitted by me or other person
to any other University or
Institute for a Degree
or Diploma*

Place: Dhule
Dated: 31.05.2013

(S. S. Khetmalas)

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Maharashtra, (INDIA).

CERTIFICATE

This is to certify that the thesis entitled, **“STANDARDIZATION OF GRAFTING TIME IN JAMUN (*Syzygium cumini* L.) UNDER NORTH MAHARASHTRA CONDITIONS”**, submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State, India, in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **FRUIT SCIENCE** embodies the results of piece of *bona fide* research work carried out by **MR. KHETMALAS SURAJ SUDHAKAR**, under my guidance and supervision and that no part of the thesis has been submitted to any other university for Degree or Diploma or publication in other form.

The assistance and help received during the course of this investigation and sources of reference have been duly acknowledged.

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Date: 31.05.2013

(S. D. Patil)

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Place: Dhule

Date: 31/05/2013.

(P. K. Dharne)

Associate Dean

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Place: Dhule

(S. S. Khetmalas)

Date: 31.05.2013

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LIST OF ABBREVIATIONS

%	Per cent
/	Per
@	At the rate of
°C	Degree Celsius
Abst.	Abstract
C.D.	Critical difference
cm.	Centimeter
cv.	Cultivar
Dia	Diameter
<i>et al.</i>	And others (<i>et alli</i>)
etc.	And so forth (<i>et Cetera</i>)
Fig.	Figure
i.e.	That is
mm	Milimeter
No.	Number
Pp	Page (s)
S.E. (m) $\pm$	Standard error of mean
T	Treatment
Var.	Variety
Viz.,	Namely

ABSTRACT

STANDARDIZATION OF GRAFTING TIME IN JAMUN (*Syzygium cumini* L.) UNDER NORTH MAHARASHTRA CONDITIONS

By

Mr. SURAJ SUDHAKAR KHETMALAS

A candidate for the degree
of
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in
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2013

Chairman and Research Guide : Dr. S. D. Patil

**Discipline : Horticulture (Fruit Science)
College of Agriculture, Dhule**

Jamun is mainly propagated by Seeds. Being heterozygous and highly cross pollinated, nature of plants raised by seed are seldom true to type. To meet the greater demand of grafts and considering the limitations in propagation of jamun by other vegetative methods, the experiment was undertaken to explore the possibility along with suitable time of softwood wedge grafting.

Present experiment was carried out in the Nursery Block, Department of Horticulture, College of Agriculture, Dhule which was laid out in RBD with three replications. Softwood wedge grafting was tried at fortnight interval commencing from 15th July to 30th October 2012. Soft wood grafting was performed on one year old seedlings of local cultivar having uniform stem of pencil thickness as rootstock.

Experimental results showed significant differences in days required for sprouting, per cent success at 30 days, number of leaves, number of branches, diameter of scion, diameter of rootstock, number of internodes, length of internodes and survival percentage

over success of grafts in different time of grafting intervals. It was found that, minimum number of days required for sprouting (16.20 days), highest per cent success at 30 days i. e. initial success (78.33%), maximum number of leaves (10.40, 14.87, 18.53, 21.80 and 23.33) and maximum number of branches (2.13, 2.60, 2.73, 3.34 and 3.80).

Diameter of scion (11.60, 11.68, 11.80, 12.00 and 12.10 mm), diameter of rootstock (11.43, 11.51, 11.63, 11.83 and 11.88 mm), number of internodes (5.13, 6.60, 8.93, 10.53 and 12.53), length of internodes (1.31, 1.70, 2.09, 2.58 and 2.73 cm) at 60, 90, 120, 150 and 180 days after grafting and survivality of grafts at 60, 90, 120, 150 and 180 days after grafting (97.87, 93.62, 89.36, 80.85 and 76.59 per cent, respectively) were recorded in jamun plants when grafted on 30th August, 2012 (T₄) amongst the different time intervals of softwood grafting. (Survival percentage over success of grafts was calculated by considering per cent success at 30 days as 100%).

In Conclusion, it has pointed out that 2nd fortnight of August month (i.e. 30th August) is an appropriate time for softwood wedge grafting on one year age old rootstock which showed higher success percentage and vigorous growth performance along with higher survival percentage in jamun under North Maharashtra condition followed by 1st fortnight of August (i.e. 15th August).

1. INTRODUCTION

The Jamun (*Syzygium cumini* L. Skeel) is an important minor fruit crop having commercial value. It is quite hardy, prolific bearer, highly remunerative and even grown without much care and attention. The original habitat of jamun is confusing and said to be either in India or in West Indies or Myanmar and Sri Lanka or Malaysia. It belongs to family Myrtaceae, having chromosome no. $2n=40$ and is commonly known by several names as Jamun, Jaman, Jambul, Jambolanum, Kalajam, Phalani or Phalinda. In other countries it is called as black plum, Java plum, Jambolan plum, Jambul or Indian blackberry.

Information regarding area and production of this fruit in India is not available because it is not grown on commercial scale but trees in patches are common in the village in many states. They can be seen in the park, on roadsides, avenues, on boundaries and as windbreak. The production in India is mainly concentrated in the dry regions and the produce is collected by the villagers and sold in the local market. The production potential of jamun depends on the demand for the products. The cultivation of jamun can be done in arid and semiarid, resource for poor and wastelands areas where other crops cannot be grown.

Jamun survived and grew better under lower salinity and shallower waterlogged condition (Hebbara *et al.*, 2002). Jamun trees survive in alkali soils up to 10.5 pH and grow well in semiarid subtropical region with an annual rainfall varying from 350-500 mm (Vashishtha, 1991). The jamun requires dry weather at the time of

flowering and fruit setting. In sub-tropical areas, early rain is considered to be beneficial for ripening of fruit and proper development of its size, colour and taste.

The Jamun is large growing, evergreen tree attaining a height of 3-4 meter and girth of 25-30 meter. This long lived tree bearing fruits up to 60-70 years is usually with crooked branches and a tendency to droop smaller branches, on the whole forming a beautiful shaped tree. The bark is brown or grayish, fairly smooth, up to 2.5 cm. thick with a shallow depression exfoliating as woody scales.

Leaves are smooth, shiny, lanceolate, oblong or elliptical or hardy or broadly ovate, gland dotted. Greenish white fragrant flowers in trichotomous particles commence in the first week of March and continue up to the end of April. Fruits are oblong-ovoid, ellipsoid or oblong, purplish black and pinkish shade, juicy with fleshy berry. Seed is single oblong.

Flowers of jamun are hermaphrodite which appears in the axils of the leaves. Peak time of anthesis and dehiscence was observed between 10.00 and 12.00 hrs. The stigma becomes receptive one day before the anthesis and remains receptive up to 5th day (Mishra and Bajpai, 1975). It is a cross pollinated crop and pollination is carried out by insect, wind and gravity.

Jamun has many valuable properties and virtually every part of the tree has been utilized by both urban and rural dwellers. The jamun timber is used in buildings, for agriculture implements and for well work as it resists the action of water (Chundawat, 1990). The fruit is

good source of iron, sugars, minerals, proteins and carbohydrates etc. Fully ripen fruits are eaten fresh and can be processed into beverages like jelly, jam, squash, wine, vinegar, and pickles. The jamun fruit has sub-acid spicy flavour. The little quantity of fruit syrup is much useful for curing diarrhea. The vinegar prepared from juice extracted from slightly unripe fruit is stomachic, carminative and diuretic, apart from having cooling and digestive properties (Thaper, 1958).

Mostly seed grown trees are distributed all over the world and therefore existing trees are highly heterozygous. The shape of trees of those two types also varies greatly in nature. There are about 400 to 500 species of which a few provide edible fruits. The most common variety commercially grown in north India is 'Ra-Jamun' (Pareek and Sharma, 1993) with oblong fruits 2.50-3.50 cm. of length and 1.5-2.0 cm. of diameter deep purple or bluish black in colour when fully mature. Purplish pink pulp is very juicy and sweet with a very small seed. The fruit ripens in June-July. A late cultivar, maturing in August, have slightly roundish fruit of small size of 1.5 to 2.0 cm. length and diameter of 1.0 to 1.5 cm. deep purple or blackish in colour at maturity is also found in cultivation. Pulp of these fruits is purple, less juicy and sweet in comparison to 'Ra-Jamun'.

A wide range of variability occurs with regards to fruit size and quality owing to its seed propagation that needs to be conserved and exploited (Devi *et al.* 2002). True-to-type propagules could be multiplied from elite trees that produce good quality fruits only by asexual methods.

Sexually propagated plants come into bearing very late as compared to vegetatively propagated. Of various methods of propagation, grafting and budding are of paramount importance in fruit trees as it results highest success in field establishment of jamun (*Syzygium cumini* L. Skeel), aonla (*Emblica officinalis* Gaertn), Khejri (*Prosopis cineraria*), lasoda (*Cordia myxa*), tamrind (*Tamrindus indica* L.) and custard apple (*Annona squamosa* L.) (Chovatia and Singh 2000, Srivastava *et al.* 2002, Pareek and Purohit 2002, Singh *et al.* 2003, Awashi and Shukla, 2003 and Ghosh *et al.* 2004). The present day nursery practice will involve much cost and risk with respect to raising of seedling and subsequent maintenance of seedling or rootstocks till they attain graftable size. Healthy growth of rootstock and correct grafting technique probably will help to attain higher rate of success.

The time of propagation by vegetative means is considered to be the most vital factor that determines the success and establishment of grafts. Systematic information in this regard is scanty, so that an investigation was undertaken to standardize grafting time of jamun under semi-arid environmental conditions of North Maharashtra with following objectives:

1. To standardize suitable time for wedge grafting in jamun.
2. To study the performance of wedge grafting of jamun during different periods.
3. To study survival percentage and growth of grafted plants of jamun at nursery stage.

2. REVIEW OF LITEATURE

The jamun (*Syzygium cumini* L.), a member of family Myrtaceae is one of the important underutilized fruits widely distributed throughout tropic and subtropics as stray plantation or avenue. A wide range of variability occurs with regards to fruit size and quality owing to its seed propagation that needs to be conserved and exploited.

Jamun is generally propagated by seeds sowing in nursery and one-year-old seedlings are planted in the main field. Because of its medicinal values and suitability for planting as windbreak, its demand is increasing day by day that will require selected plants of superior quality and high yield potential. It is only possible when desirable mother trees are used for vegetative propagation. Therefore, main objective of the present study was to find out optimum time of grafting of jamun by softwood grafting but the available information on various aspects of grafting in jamun is very meager. Hence, literature available on other fruit crops grown under similar situation have been reviewed in relation to present investigation and consideration as under-

Teaotia and Asthana (1960) and Moti and Chaturvedi (1976) reported that July and May to be the optimum period of budding in aonla.

Swamy (1962) revealed 75% success in custard apple budding on its own seedling, but side grafting recorded less. He also stated that, success by inarching

varied from 50 to 87.5% according to the season of operation.

Holmquist (1966) achieved 98% success in lateral cleft grafting and 93% in veneer grafting and observed 75% success union in case of chip and shield budding on 30-45 days old seedlings, but many buds fail after union in avocado.

Jauhari and Singh (1970) reported that humidity of the environment being an important factor in propagation of mango; it appears that increased humidity in July (RH- 93%) was responsible for increased success than in March (RH- 60%).

Mujumdar and Rathore (1970) was opinioned that there should be high humidity in atmosphere for better success of epicotyl grafting in mango.

Amin (1974) reported that out of 211 mango stocks grafted in the nursery field of the Anand campus, 208 grafts sprouted successfully giving 98.5 per cent success. He also observed that grafting "*in-situ*" on the bronze leaf coloured stock of mango plant by wedge method with one or two weeks defoliated scion gave 91 per cent success in nursery grown seedling and 75 per cent in cultivator's field without irrigation.

Misra and Bajpai (1975) observed that during 1966-67 period, the length and diameter of shoot was 22.9 cm and 0.86 cm respectively and had 9.50 nodes with 19 leaves, while during 1967-68 the length and diameter of shoot was 19.60 cm and 0.81 cm respectively and had 10 nodes and 20 leaves.

Amin (1978) reported softwood grafting of mango on, *in-situ* grown (one year or more old) mango stocks tried gave 100% success at Gujarat Agricultural University.

Amin (1978c) indicated that 67.65 per cent grafted plants survived in the treatment of immediate removal of all leaves from the stock, while 100 per cent survival was found in the treatments of immediate removal of leaves from the lower half of the stock and retaining all the leaves on the stock.

Pandey and Prasad (1980) reported that the maximum growth under patch budding method in aonla was obtained from May budding followed by June, July, August, September and October respectively. Maximum success (91.67%) was observed from patch budding done in June. The highest linear growth (46.80 cm) was recorded under patch budding done during May.

Sharma and Chauhan (1980) reported that, the highest percentage of success in Walnut (40.0) was obtained in side tongue grafting followed by crown grafting which gave 22.5 per cent success. The highest per cent of survival (38.7%) was obtained in side tongue, whereas the lowest survival (10.0%) was recorded in cleft grafting.

Singh and Srivastava (1980) results indicated in mango was maximum success recorded under Inarching-Soft wood grafting (both grafted in July), Inarching-Inarching (grafted in July and September respectively) followed by Inarching-Soft wood grafting (grafted in July and September) and Inarching-Inarching (grafted in March and July).

Patel and Amin (1981) observed that highest graft-take in first week of June (100%) and third week of August (100%) while no graft-take in third week of October (0.00%) after two months of graft. Those plants grafted in third week in August shows highest success (100%) after 6 months of grafting. While the grafting period of second fortnight of April resulted maximum height of scion growth from the grafted portion (74.21 cm) and also resulted in the production of maximum number of leaves (113.53) in mango.

Samaddar and Yadav (1982) obtained very high success in cashewnut and avocado by chip budding was propagated in the month September and October respectively.

Singh and Srivastava (1982) reported that a favourable condition for grafting in mango was prevailed during July to September and thereby maximum success was recorded during August. Soft wood grafting gave better performance in comparison to veneer grafting in success as well as growth of extension shoot in early stage.

Dhakal (1983) reported that the best time for grafting was found to be from June to August. The success rate was highly influenced by monthly minimum temperature, relative humidity and maturity of scions.

Patil *et al.* (1983) reported that retention of 4 leaves on the stock of the graft induced quicker sprouting and increased the success of grafting, the height of scion sprout and the number of leaves. The sprouting was delayed and all the other attributes were decreased with reducing the number of leaves on the stock.

Desai and Patil (1984) reported that the highest success was noted with soft wood grafting done on 1st July and when the grafts were kept in glasshouse. During this period, humidity and temperature were greater in glasshouse than open condition. Relative humidity was 83 per cent and maximum temperature was 41^o C in glasshouse.

Nagawekar *et al.* (1984) reported that survival of stone grafts of mango made *in-situ* (Polythene bags) 65.42% with height of 35.42 cm and 7.30 mm diameter.

Patil *et al.* (1984) reported that minimum number of days (average 16.13) was required for sprouting in 7 days defoliation, while 18.51 and 20.54 days were required in treatments of 5 days and 3 days defoliation respectively. The initial and final success was superior in 4 days old rootstock and 5 days defoliation. The growth criteria i. e. height of plant, number of leaves and diameter of stock and scion were significantly more in the treatment of four days old stock in mango.

Singh *et al.* (1984) observed that soft wood grafting done in the middle of June, July, August and September found significantly superior as compared to mid of April and May. Minimum day taken for sprouting was 12, when grafting was done in mid of June and maximum was 23 when grafting done in mid April. Maximum growth of scion 33.0 cm was recorded after 90 days when the grafting was done in mid June.

Kulwal *et al.* (1985) revealed that success was very high (52 to 90%) in sapota during the grafting period from mid July to October but it was reduced below 40% in

the later period. Grafts prepared during the period of November and thereafter were very slow to sprout, taking 40 to 48 days. The mortality of grafts after sprouting was observed to be just minimum within 90 days of grafting. However, in grafts prepared during January and thereafter, mortality was nearly cent percent. Number of leaves produced by the scion after 120 days was slightly influenced being more in grafts prepared in mid August and September. The results shown that, soft wood grafts of sapota could be prepared from mid-July to mid-August with more than 80% success and with over 50% success from September to October under Akola condition.

Reddy and Kohil (1985) showed that in mango epicotyl grafting was successful only when grafts were kept in the mist chamber where temperature and humidity were higher.

Sawke *et al.* (1985) softwood grafting is sure method of vegetative propagation under warm and humid climate. The method has a long span of operation and can be practiced throughout the year, except December, with high degree of success in cashew. The month of August was most congenial followed by April with 83.66 and 83 per cent success respectively under Konkan conditions.

Hartman and Kester (1986) also reported that success of budding or grafting operation is influenced by several factors, viz. physiological condition of stock and scion, hormonal balance of stock and scion, sap flowing condition at various stages of plant growth viz. dormancy period, new flush emergence, blossom bud differentiation and flowering also influence the success of budding or

grafting operation, In addition to internal factors of plants growth, the climatic factors mainly prevailing maximum and minimum temperature ranging from 12.1°C to 32°C depending upon species are conducive to rapid growth (cell activity).

Seshadri and Rao (1986) reported that, percent success of graft on the rootstock of 75 days old pretreated with water is 42.12% and 105 days old pretreated with water is 18.61% in Cashew.

Hulamani and Kumar (1987) found that epicotyl grafting was highly successful in mango when it is done from June-July.

Ratan *et al.* (1987) observed that when mature 3 to 4 month old, ten days precured scion of 8 cm length were grafted on five to ten days old rootstock at 6-8 cm height gave maximum percentage of sprouting and survival during July-August in mango.

Gupta *et al.* (1988) revealed that the success during second fortnight of August and the first fortnight of September on ten days old rootstock was significantly better than on 5 and 15 days old seedling during the period. The success with splice (57%) followed by side (46%) and veneer grafting (40%) was better than wedge and saddle (27 and 24%) grafting in mango.

Reddy and Melanta (1988) reported in Mango, the highest success rate observed on seven month old rootstock might be due to low temperature and higher relative humidity during the period of grafting on rootstock of other age groups.

Gowda and Melanta (1989) reported that the younger rootstock give more success in soft wood grafting than older ones in cashewnut.

Madalageri *et al.* (1990) observed that highest success percentage of softwood grafting in sapota was recorded during January to July under Dharwad condition.

Swamy *et al.* (1990) reported that commercial cashew graft production in mansoon season (June-October) was found to be ideal as the success was above 60% during this season. During other months the success was poor due to unfavourable weather conditions and non availability of suitable scion sticks. Per cent success was highly correlated with the higher monthly mean minimum temperature and relative humidity.

Jose and Valsalakumar (1991) found that softwood grafts of jackfruit was sprouted more under mist condition (3.89 %), likewise the survival rate was also high under mist condition (2.5 %) as against open condition (0.56%).

Sarade *et al.* (1991) carried out an experiment at Cashew Research Station, Bapatla. Softwood grafting in cashew carried out from 20th January at monthly interval with procured 10 cm long scion shoot taken from mature trees revealed that the per cent success and growth of grafts was maximum during August (65.43%), September (60.63%) and January (53.36%) months followed by gradual decrease upto December and increase thereafter.

Haldankar *et al.* (1992) revealed that percentage of survival increased with an increase in age of the scion stick. The average number of days required for sprouting

varied from 19 days (in 13 to 15 days prior defoliated scion sticks) to 23 days (in non-defoliated scion sticks). Defoliation of scion sticks before grafting did not give added advantage in soft wood grafting of kokam. The rootstock of 26 weeks old age showed highest survival (62.03).

Kelaskar *et al.* (1992) reported that under glass house mean sprouting percentage was 58.74%, mean survival percentage was 57.46 %. After three months mean number of leaves was 5.12 while mean length of sprout was 11.88 cm by forkert bud grafts in jackfruit.

Patil *et al.* (1994) revealed that in jackfruit when the grafting done during second week of July had highest success (80%) followed by the grafting done in first week of July (60%). The grafting done during second week of July also recorded height of the graft (28.0 cm) as well as more number of leaves (4.0). The least graft success was seen with the grafting done during the first week of July.

Pampanna *et al.* (1995) revealed that soft wood grafting in sapota during the month of May was proved to be superior, followed by April under Dharwad condition. The highest graft-take (63.33%), the maximum growth of scion shoot (16.06 cm) and the highest number of leaves on the scion shoot (15.08) were obtained when the grafting was done during the month of May.

Shinde *et al.* (1996) reported that, soft wood grafting done in the month of March, April after harvesting and before flowering resulted in maximum success in tamarind. The per cent success during this period ranged between 60.06 to 70.00. Further it was also observed that girth above and below the matrix joint was maximum when

done in the month of March followed by April. Also the maximum height of graft (30 cm) was found when grafting done in the second week of March.

Geetha *et al.* (1997) observed that the maximum percentage of success (96.67) in mango was obtained when Muvandan and Chandrakaran rootstock were grafted with Neelum scion during June. But when Chandrakaran rootstock was grafted with Banganpally scion during July the percentage of success was lowest (33.33%). Survival of graft was maximum (76.67%) for treatment combination. Puliyan rootstock grafted with Banganpally scion during August. Tholikaipan rootstock grafted with Banganpally scion during June did not survive.

Reddy *et al.* (1998) reported that when grafting is done in March, showed highest percentage of success (100%) with least number of days for sprouting (13.7 day) in tamarind.

March and April was the best months for soft wood grafting under Akola condition in tamarind Bharad *et al.* (1999).

Shete *et al.* (1999) observed that among the five varieties tested, patch budding had gave more success for the cvs. Krishna (94.46%), Francis (90.91%) and NA-7 (90.91%) at M.P.K.V., Rahuri.

Early bud sprouting in Jamun plants raised by wedge grafting (16 days) Chovatia and Singh (2000). Success of grafting was observed to be more during July and it was 63.33 % followed by 61.83 % in June. Maximum shoot length of 36.24 cm and 38.22 cm was observed when

grafting done in May and April respectively. Likewise maximum shoot diameter in month of May and June and which was 7.29 cm and 6.79 cm respectively. Also the maximum number of functional leaves were observed in the month of May (17.91) followed by June (16.08).

Joshi *et al.* (2000) reported that percentage of bud take was highest in plants propagated in August (74.44%) and lowest in plants propagated in May (36.66%). Shield budding resulted in minimum number of days to sprouting (40.70 days) than patch budding (41.08 days) and softwood grafting (63.68 days) in Balanagar cultivar of custard apple.

Pampanna and Sulikeri (2000) reported that in sapota, initial and final graft-take was highest with May grafting (both 60%) followed by April grafting (both 43.33%). The maximum success may be ascribed to the prevailing favourable conditions like higher maximum temperature (36.60°C), the higher minimum temperature (20.90°C) and optimum humidity (65%) resulting in increased cell activity and better union of the stock and scion. On 120th and 180th day after grafting higher of the scion shoot (15.00 and 17.47 cm respectively) and number of leaves (9.67 and 14.83 leaves/graft, respectively) were maximum with grafts prepared during the month of May, followed by April (13.20; 15.56 cm and 8.75; 14.0); June (12.46; 14.73 cm and 8.17; 13.42, respectively).

Maximum success of graft were observed during the month of July (37%) followed by September (32%) and the lowest success of graft was observed during December (1%) followed by January (1.5%) and November month (2%)

Haldankar and Jadhav (2001). They also stated that survival of clove on jamun was between 14 to 18% during February, April, May and October month when the difference between minimum and maximum temperature was 10-12°C. The maximum total leaves were observed when grafts were prepared during the month of March followed by August, Feb and May. The grafts prepared in the month of July, August and March produced more length and breadth of leaves as well as length of new shoots than other grafts while grafting of clove on Jamun root stock.

Joolka *et al.* (2001) reported that highest bud sprouting and survival rate were recorded in tongue grafting performed on 3rd March followed by the same method performed on 15th February. Cleft graft on 18th March was the earliest to sprout. The proportion of saleable plants was highest in tongue grafting (71.33%) followed by cleft grafting (61.44%) i.e. tongue grafting gave highest success compared to cleft grafting in pecan.

Palande (2001) tried soft wood grafting in tamarind at MPKV, Rahuri. Soft wood grafting was carried out at monthly intervals from 15th January to 15th December, the maximum success in sprouting (60%) and subsequent survival (50%) was observed when soft wood grafting was performed on 15th May. He pointed out that mid April to mid June and mid-October is the best time for soft wood grafting for tamarind under semi-arid conditions of Rahuri.

Palande *et al.* (2002) reported that 76% of success by patch budding in May under Maharashtra condition in tamarind.

In Aonla showed the maximum success (87%) was obtained during the second fortnight of August, followed by first fortnight of the same month (83%). During other period the success was 67 and 74 per cent in first and second fortnight of July, and 70 and 66 per cent in first and second fortnight of September respectively, recorded by Tewari and Bajpai (2002).

Awasthi and Shukla (2003) found that soft wood grafted plants of tamarind recorded higher number of leaves/plant when compared with patch budded plants. The maximum number of leaves/plant, i.e. 18.90 was recorded in soft wood grafted plants after 150 days of grafting.

Pawar *et al.* (2003) revealed that softwood grafting in custard apple was effective in terms of percent success (87.02%), percent survival (73.73%), shoot length (37.08 cm) and number of functional leaves (12.10) when grafting was performed during February on 12 month old rootstock.

Satishkumar *et al* (2003) observed highest graft success (51.96%) of the growth period between May-December on 8 month old rootstock in Tamrind. Higher sprout length in 10 month old rootstock age group may be due to the thicker scion shoots used for the grafting as they may have reserve food material for the better development of the sprout.

Singh *et al.* (2003) experienced that early sprouting of budded plant was observed in the month of July in lasoda (*Cordia myxa*).

Islam *et al.* (2004) reported that the percentage of success was higher by modified cleft grafting in June and higher in August by veneer grafting. Propagation of plants during June by modified cleft grafting showed highest scion growth with highest number of leaves and shoots in mango.

Patil (2004) revealed that maximum success was achieved in Aonla through wedge grafting (91.6%) in mid-August followed by patch budding (85.0%). In general, wedge grafting performed in mid-August initiated the earliest sprouts with maximum success followed by July.

Singh *et al.* (2004) reported that highest bud take (59.1%) in Jamun was observed when budding on 15th June using the patch method. Seedlings budded on 15th June by patch method showed the best performance in terms of bud take, bud sprouting, height and diameter of budding, branch number and leaf number.

Aulakh and Bawa (2005) reported that “In-situ” grafting in mango showed highest success in the month of July (60-85 %) and least in May (20%). More shoot growth was also found in July (93 cm height and 1.9 cm shoot girth) as compared to the month of May which is due to moderate climate.

Alam *et al.* (2006) reported that the grafts of 30 days old seedlings took maximum days to sprouting (16.07 days), while minimum day to sprouting was coupled for the grafts of 10 days seedlings (12.98 days). Maximum final

success (48.89%) was achieved from the grafts made with 15 days old seedlings followed by 20 days old seedlings. The grafts of 15 days old seedlings produced highest number of leaves per plant (13.20) in mango.

Gangadeep and Malhi (2006) observed that survival was better in soil + FYM + sand followed by soil + FYM after 4 months of grafting by using epicotyl grafting in mango. The survival percentage was higher in transplanted grafts than those grafted in-situ in poly bags. Vegetative growth viz. sprout length and sprout diameter were the highest in plants grafted on 7 days old rootstock followed by 9 and 11 days old rootstocks in mango.

Mannan *et al.* (2006) found that higher values of success (84.99%) was found with 7 days old rootstock and the highest time was required to bud break (35 days), to emergence of first leaf (38.78 days), and to first flush (42.83 days) in 14 days old rootstock, whereas the highest percentage of survivality (99.98%) was recorded in 7 and 14 days old rootstocks in cleft grafting. Number of leaves, length of leaves and breadth of leaves were also higher in cleft grafting with 7 days, 10 days and 14 days old rootstocks respectively.

Panchbhai *et al.* (2006) revealed that maximum success percentage was observed in soft wood grafting than patch budding. High percentage of success in soft wood grafting was recorded in the month of January (86%), whereas in patch budding maximum success observed in August (40%) in aonla.

Singh and Singh (2006) revealed that higher percentage of graft success in jamun was found in March (40 %) in patch budded plants, whereas it was recorded to be highest in soft wood grafted plants in August (36 %). In general, soft wood grafted plants recorded higher numbers of leaves/plant when compared with patch budded plants. The maximum number of leaves/plant i.e. 17.18 and 18.90 in March patch budded and soft wood grafted plants after 150 days of grafting respectively.

Giri and Lenka (2007a) reported that highest percentage of success in tamarind was found in month of Aug (73.66%) followed by June (69%) and July (65%). Similarly least number of days was taken for sprouting in the month of Aug and May (10.3 days). The height of the plant after 90 days varied from 20.67 cm (December) to 32 cm (July). The number of leaves after 90 days varied from 6.33 (December) to 18.67 (July) under Bhubaneswar agro climatic condition.

Highest percentage of success of grafting in the month of May (93.66%) followed by April (93.33%) and December (92.33%). Minimum percentage of success was noticed in October (73.33%) grafting. Minimum number of days for sprouting was needed in June grafting (8.6 days) and July (9.3 days). Maximum number of days required for sprouting in December. (22 Days). Number of leaves after 90 days highest (15.00) in July while lowest (7.67) in November. The maximum height of plant (43.33 cm) was recorded after 90 days in July by Giri and Lenka (2007b).

Patel *et al.* (2007) observed that the maximum graft success rate of 93.1% was recorded for plants grafted on 30th July followed by 15th July 92.9%, 15th August 88.2% and 30th June 81.3%, while grafting on 15th October gave the poorest graft success (38.3%). However, the maximum plant survival 80.2% was recorded for plants grafted of 30th August followed by 70.4% 30 July and 66.6% 15th September and was worst 32.9% for 30th June in mandarin.

Prasanth *et al.* (2007) revealed that effect of time of grafting on the days taken for sprouting, it was early with second fortnight of September (24.50 days) and it was late by 17.28 days in second fortnight of December in mango. Maximum percentage of sprouting was observed during first fortnight of September (82.50%), whereas minimum percentage of sprouting was with second fortnight of December (32.00%), while survival percentage is concerned, softwood grafting done in the first fortnight of September has recorded highest survival percentage (54.56%) and lowest was with second fortnight of December (16.10%). The success was recorded with second fortnight of December which may be due to the low average temperature, relative humidity and no precipitation.

Singh and Singh (2007) reported that Patch budded plants of tamarind sprouted earliest during August (22 days) followed by July (23 days) and June (24.25 days). The maximum time was taken when budding performed in the February (32 days). Higher percentage of graft success was noted in August in patch budded plants, whereas it

was recorded to be highest in soft wood grafted plants in the month of May, closely followed by April. Soft-wood grafted plants had the higher number of leaves than patch budded plants. They also concluded that patch budding performed in July-August and soft wood grafting performed in April-May may be adopted in the region for multiplication of elite tamarind genotypes.

Soft wood grafting followed during February recorded highest success (88.87%), maximum scion length, maximum number of leaves were observed in custard apple Kudmulwar *et al.* (2008).

Meshram and Apprao (2008) reported that the treatment in which leaves were retained in the upper half and all along the rootstock stem the survival was 93.33% and 100 per cent respectively after 21 months of graft. The high take scope is attributed to the grafting on softwood, the survival depends on the nourishment provided by the leaves on the stock.

Patil *et al.* (2008) revealed that Alphanso grafted (softwood) on Sindhura significantly the highest graft success (77.80%) and Nekkare recorded the maximum graft survival (64.77%), which was on par with Sindhura.

Selvi *et al.* (2008) reported that the soft wood graft success in jackfruit was relatively higher under agro-shade net followed by mist chamber and the least success was observed under tree shade. The maximum percentage of success obtained during October may be related to the prevailing optimum maximum and minimum temperatures with least disparity coupled with higher humidity

experienced. Minimum days (19.89) in October while maximum days (26.50) in September for graft union under 50 % agro-shade were required.

Yelleshkumar *et al.* (2008) observed that maximum graft success (76.15%) in mango was noticed in *Panchagavya* three per cent followed by water soaking (74.17) and GA3 – 100 ppm (73.73%). whereas maximum graft survival was observed in *Panchagavya* three per cent (76.15%) and significantly least graft success was noticed in control (64.07%).

Bharad and Mahorkar (2009) revealed that softwood grafting in Jamun was carried out during March showed significantly higher graft success followed by softwood grafting in September whereas patch budding showed the least survival percentage.

Chandra *et al.* (2009) observed that significantly higher scion sprouting was recorded with wedge grafting done in the last week of January after 15 (90.00%) and 21 (96.67%) days of grafting in pomegranate. Consequently maximum graft success (85.00%) was recorded after 90 days of grafting with wedge grafting done on 30th January. Plant height and scion length after 6 months of grafting was higher when wedge grafting was done between 30th December and 30th January.

Ghojage *et al.* (2009) revealed that the maximum graft survival in jamun was recorded during February (95.97 %) followed by October (95.83 %), September (93.97 %) and June (93.02 %) which are on par with each other.

Ghosh *et al.* (2010) reported highest softwood grafting success in sapota when carried out on 1st July (72%) followed by 15th August (70%), 5th June (62%) and 15th June (56%).

Shinde and Jogdande (2010) observed that significantly early sprouting of grafts was noticed in mandarin by top cut surface method in 14.75 days. Although this method gave the earliest sprouting with maximum shoot length 1.75 cm but percent success of Shoot tip grafting (STG) was low. The maximum grafting success of 37.25 % was achieved by apical triangle cut method.

Shinde *et al.* (2010) in Jamun experienced that among three structural conditions (Open condition, net house and Open vent green house) open condition recorded significantly highest number of sprouted grafts (13.2), minimum days required for sprouting of grafts (22.9) and thereby maximum survival percentage (75.32%) at 90 days after grafting.

Visen Amit *et al.* (2010) reported that resulted maximum success of guava grafts in greenhouse (81.71%) and minimum in open field conditions when grafting was carried out during September to December. Grafting under greenhouse significantly reduced the time taken (12–13 days) for sprouting than those grafted in open field conditions. The temperature range of 24 to 26°C and 70 to 80 per cent RH were found most conducive for achieving maximum success.

Gadekar *et al.* (2011) revealed that maximum length of scion 11.17 cm was observed in grafts which are grafted on 15th Feb, while 10.21 cm on 15th July and 3.31 cm on 1st Oct. The maximum number of leaves per plant 13.25 was noticed. The higher percentage of survival (85.00%) was found in plants propagated on 15th September and followed by 15th March (70.00%) whereas minimum final survival (17.50%) was observed when grafting was done during 1st March.

Mulla *et al.* (2011) reported that graft take of jamun was maximum (100%) in December and May. The survival percentage was the highest (93.33%) in October, November, May and significantly less (26.67 days) number of days taken for initiation of sprout in June. This may be due to favourable climatic condition during these months such as moderate temperature (28°C to 32°C) and relative humidity (74% to 78%). The graft prepared during June month recorded the highest number of leaves (12.48) compared to any other months. The grafts prepared during May month showed highest (5.34 cm) sprout length. A higher number of leaves (12.48) was recorded in June, the highest leaf area (34.8 cm²) and sprout length (5.34 cm) were observed in May. Under controlled conditions, during October, November and December produced the highest graft take and survival percentage (100%).

Nachegowda *et al.* (2011) studied softwood grafting in jamun and revealed that jamun can be very well grafted on its own and *Syzygium operculatum* rootstocks.

Soft wood grafting during June recorded maximum grafting success in jamun.

Raghavendra *et al.* (2011) revealed that ten months old rootstock taken less (23.8) days for sprouting with maximum number of leaves (13.7) while eight month old rootstock has produced highest (97.1%) per cent success and maximum (96.2%) survival percentage.

Shinde *et al.* (2011) recorded that on 30th May grafts shows highest increment in length of scion i.e. 15.12 and 20.81% at 60 and 90 days after grafting, 15th May grafts shows highest increment in girth of scion at 90 days after grafting i.e. 137.40% in case of rootstock, while highest increment in girth i.e. 43.30, 54.61, 65.70% of rootstock was observed on 15th May at 30, 60 and 90 days after grafting respectively. The number of sprouted grafts were maximum i.e. 22.7 on 30th July, significantly highest number of leaves i.e. 5.4 were recorded when grafting performed on 15th May. Survival percentage was i.e. 73.36 and 77.76% on 15th May at 60 and 90 days after grafting, respectively in jamun.

Angadi and Karadi (2012) showed that the 11-19 months old rootstocks during April to November, respectively, produced better percent success and survival of jamun grafts. On the other hand, 13 months old rootstocks with softwood grafting in June performed better compared to all the other treatments with respect to success, survival percentages and growth attributes of jamun grafts.

Singh *et al.* (2012) revealed that veneer grafting performed in mango on 15th July recorded minimum time (13.00 days) for bud sprouting, the highest graft-take success (96.66 per cent) and survival (90 per cent). The same grafting methods i.e. veneer grafting while performed on 30th June, 15th July and 30th July produced maximum scion radial growth (12.14 mm), scion linear growth (26.25 cm) and number of leaves (24) respectively after 180 days of grafting. It is clearly indicated that veneer grafting in the month of July was proved to be the best propagation technique for higher success and growth of mango grafts.

Suharto *et al.* (2012) reported that the relative air humidity of 74.57% was found to give 100% scion survival rate in cashew. The treatment combination of two scions grafted and two productive branches remaining resulted in the highest figures for new shoot length (24.85 cm), number of leaves (27.91 leaves) and per cent of flower bearing fruits (69.57 %). The survival rate of scions grafted was 81.55% at 210 days after grafting and 75% of new shoots flowered at 113 days after grafting at Eastern Indonesia.

Verma *et al.* (2012) reported that highest graft take success was registered in wedge grafting followed by side grafting in all the three months, while for bench grafting, the highest graft take was recorded in the month of February. The graft take was the maximum at the height of 30 cm, while the minimum was noted at 15 cm of the three grafting months (February, March and August); February was found the best with respect to percentage graft success and survival in grape.

3. MATERIAL AND METHODS

Programme of research work on “Standardization of grafting time in jamun (*Syzygium cumini* L.) under North Maharashtra conditions” was conducted at Research Farm, Horticulture Section, College of Agriculture Dhule 424 004 during the year 2012-2013. Soft wood grafting method of propagation was executed on the rootstock of local cultivar of jamun with single clone tree were selected for scion material at new orchard, Department of Horticulture, College of Agriculture, Dhule. One season old shoots of the pencil thickness free from pest and diseases were selected. Soft wood wedge grafting was performed at fortnight interval from July, 2012 to October, 2012.

3.1 Material

The trial was laid out in the randomized block design with eight treatments and three replications. For softwood grafting of jamun, twenty seedlings of local cultivar having one year old age were used as rootstock having uniform growth (about pencil size thickness) was selected for performing soft wood grafting. The scion wood of jamun clone tree of last season growth was used for grafting. Twenty plants forming a unit for each treatment in each replication. The trial was conducted during 15th July, 2012 to 30th October, 2012.

3.1.1 Treatment Details

Schedule of softwood/wedge grafting is as under

Treatment No.	Treatment details (Date of grafting)
T ₁	15 th July, 2012
T ₂	30 th July, 2012
T ₃	15 th August, 2012
T ₄	30 th August, 2012
T ₅	15 th September, 2012
T ₆	30 th September, 2012
T ₇	15 th October, 2012
T ₈	30 th October, 2012

3.2 Methods Adopted

3.2.1 Climate and weather condition

Dhule region receives rains mainly from south west monsoon from June to September. During the experimental period i.e. from July, 2012 to October 2012, the rainfall received 462.5 mm. The maximum and minimum temperature was 38°C and 10.6°C respectively during that period.

The meteorological data in respect of morning humidity, afternoon humidity, mean temperatures recorded at Research Farm, Horticulture Section Nursery under shade net conditions during the period of experiment are presented in the appendix-I.

3.2.2 Softwood grafting

The stock seedlings were decapitated leaving about 15 to 20 cm stem. The top was split by grafting knife to a length of about 5 cm. Scion shoot having nearly same diameter and of desired length was mended to about 4 to 4.5 cm in wedge keeping bark on both sides and fitted in slit of stem and secured firmly by polythene strip. Scion stick was pre-cured.

3.2.3 After care of grafts

The grafts were sprayed with 0.2 per cent captan at 15 days interval to prevent fungal infections. The side shoots sprouted on the stock seedlings was nipped off frequently. After sprouting of buds/grafts, polythene bags were kept in open sunlight. Grafted plants were kept under shade net condition.

3.3 Details of observations

While conducting the research following observations were recorded on five representative plants of respective treatment from time to time.

Periodically observations were recorded after 30 days intervals on the following parameters.

3.3.1 Days required for sprouting (Days)

The number of days for union of stock and scion in grafting was counted for each treatment on observational plants and the average period for each treatment was worked out in terms of days.

3.3.2 Per cent success (%) at 30 days

The percentage of successful grafting was recorded by observing each plant at 30 days after grafting.

3.3.3 Number of leaves

Numbers of leaves present on each observational grafted plant were recorded at 60, 90, 120, 150 and 180 days intervals and average was worked out respectively.

3.3.4 Number of branches

The observation of number of branches of observational grafted plants were recorded at 60, 90, 120, 150 and 180 days interval after performing softwood grafting and average was worked out respectively.

3.3.5 Diameter of scion (mm)

Diameter of scion (above one cm of graft union) of observational plants was recorded with the help of vernier caliper at 60, 90, 120, 150 and 180 days interval and average was worked out.

3.3.6 Diameter of rootstock (mm)

The observation of diameter of rootstock (below one cm of graft union) of observational plants was recorded with the help of vernier caliper at 60, 90, 120, 150 and 180 days interval and average was worked out.

3.3.7 Number of internodes

The increased numbers of internodes on observational plant were counted at 60, 90, 120, 150 and 180 days interval and average was worked out respectively.

3.3.8 Length of internodes (cm)

The length of internodes was calculated by dividing the length of scion with the number of leaves present. Observation of length of internodes of observational plants was recorded at 60, 90, 120, 150 and 180 days interval and average worked out respectively.

3.3.9 Survival percentage over success of grafts (%)

Observation for percentage of survival was recorded at the interval of 60, 90, 120, 150 and 180 days by observing each plant in the treatment by considering per cent success at 30 days as 100%.

3.3.10 Statistical Analysis

Trial was laid out in Randomized Block Design (R.B.D.) with three replications. Root stock of local cultivar of jamun was used for grafting having one year old age. The grafting was performed 15 days interval from 15th July, 2012 to 30th October, 2012. Twenty plants in each treatment per replication formed a unit. Trial was initiated from 15th July, 2012 to 30th October, 2012 and observations were recorded up to 30th March, 2012.

Statistical analysis of data was carried out as per the procedure given by Panse and Sukhatme (2000).

4. EXPERIMENTAL RESULTS

The present investigation entitled “Standardization of grafting time in jamun (*Syzygium cumini* L.) under North Maharashtra conditions” was carried out at Research Farm, Horticulture section, College of Agriculture, Dhule during 2012-13. The observation in respect of soft wood grafting were recorded and statistically analyzed as per the standard procedure. The summarized data, statistical parameters and results obtained are presented in this chapter under appropriate headings.

Table 4.1 Days required for sprouting

Treatments	Days required for sprouting
T ₁ - 15 th July	19.87
T ₂ - 30 th July	19.33
T ₃ - 15 th August	16.80
T ₄ - 30 th August	16.20
T ₅ - 15 th September	22.67
T ₆ - 30 th September	23.20
T ₇ - 15 th October	24.00
T ₈ - 30 th October	24.60
S. E. (m) ±	0.34
C. D. at 5%	1.05

The data regarding mean number of days required for sprouting of jamun grafts as influenced by time are presented in table 4.1 and depicted graphically in Fig.1.

Soft wood grafting performed in jamun in different months showed significant variation.

Significantly minimum numbers of days (16.20 days) required for sprouting of grafts were recorded when grafting was done on 30th August (T₄) which was at par with treatment T₃ (15th August). It was followed by grafting done on 30th July (T₂) and 15th July (T₁) (19.33 and 19.87 days respectively). Whereas maximum number of days were required for sprouting of grafts on 30th October (T₈) (24.60 days), which was statistically inferior. It was followed by grafting done on 15th October (24.00 days). Treatment T₈, T₇, T₆ and T₅ were at par with negative correlation with each other. However T₁ and T₂ as well as T₃ and T₄ were also at par with each other in regards negative correlation for days required for sprouting. In this treatment, grafting performed on 30th August (T₄) recorded minimum numbers of days for sprouting indicating 2nd fortnight of August is superior for softwood grafting in jamun. It was followed by grafting in July, September whereas October grafting was inferior.

Table 4.2 Per cent success at 30 days

Treatments	Per cent success at 30 days
T ₁ - 15 th July	68.33
T ₂ - 30 th July	70.00
T ₃ - 15 th August	75.00
T ₄ - 30 th August	78.33
T ₅ - 15 th September	63.33
T ₆ - 30 th September	58.33
T ₇ - 15 th October	53.33
T ₈ - 30 th October	50.00
S. E. (m) $\pm$	0.53
C. D. at 5%	1.60

As regards the data of initial success per cent at 30 days after soft wood grafting which was significantly influenced by time of grafting in jamun is presented in table 4.2 and graphically depicted in Fig. 2.

All treatments regarding soft wood grafting in jamun done at different timing were significantly differed with each other. The grafts made on 30th August (T₄) showed significantly highest per cent success (78.33%). It was followed by 15th August (T₃) (75.00%), 30th July (T₂) (70.00%) and 15th July (T₁) (68.33%). However minimum success percentage of grafts (50.00%) was recorded in the treatment (T₈) (30th October) which has statistically inferior. Whereas, treatment T₅ (15th September) (63.33%) followed by T₆ (30th September) (58.33%) and (T₇) (15th October) (53.33%).

In regards of grafting done on 30th August (T₄) recorded maximum per cent success at 30 days after grafting indicating superior among all other treatments for softwood grafting in jamun.

Table 4.3 Number of leaves at different growth stages

Treatments	No. of leaves at different growth stages				
	At 60 days	At 90 days	At 120 days	At 150 days	At 180 days
T ₁ - 15 th July	6.80	10.53	13.93	15.73	18.87
T ₂ - 30 th July	7.60	11.20	15.07	16.80	19.27
T ₃ - 15 th August	9.27	14.40	16.27	20.27	22.47
T ₄ - 30 th August	10.40	14.87	18.53	21.80	23.33
T ₅ - 15 th September	5.40	9.67	11.53	14.13	17.13
T ₆ - 30 th September	5.13	8.33	10.40	13.33	16.00
T ₇ - 15 th October	4.80	8.07	10.07	12.20	15.20
T ₈ - 30 th October	4.40	6.33	9.60	11.47	13.07
S. E. (m) ±	0.35	0.44	0.34	0.41	0.42
C. D. at 5%	1.06	1.32	1.05	1.27	1.29

The data regarding number of leaves of grafts as influenced by different time of soft wood grafting are shown in table 4.3 and graphically depicted in Fig. 3.

The number of leaves per graft at 60 days, 90 days, 120 days, 150 days and 180 days after grafting were found to be significantly influenced by time of soft wood grafting in jamun.

The number of leaves per graft at 60 days after grafting, significantly maximum number of leaves (10.40) was obtained in the treatment of 30th August (T₄) which was followed by grafting performed on 15th August (T₃) (9.27),

30th July (T₂) (7.60) and 15th July (T₁) (6.80) while minimum number of leaves (4.40) was recorded in grafting done on 30th October (T₈) whereas treatment T₂ with T₁ and treatment T₅, T₆, T₇ and T₈ were also at par with each others.

Similar trend of production of leaves was observed at 90 days after grafting in treatment T₄ (30th August), which shows maximum number of leaves (14.87) while minimum number of leaves (6.33) in the treatment T₈ (30th October).

All treatments were significantly different with each other pertaining to number of leaves produced by graft at 120 days after grafting. Whereas number of leaves produces by graft at 120 days after grafting, treatment T₄ (30th August) produced significantly maximum number of leaves (18.53) per graft followed by 15th August (T₃) (16.27), 30th July (T₂) (15.07) and 15th July (T₁) (13.93). After the treatment T₄ (30th August) onwards there was gradual and consistent decrease in production of leaves. Minimum number of leaves (9.60) was recorded when grafted on 30th October (T₈).

After 150 days of grafting, maximum number of leaves (21.80) were observed when grafting performed on 30th August (T₄) while minimum number of leaves (11.47) were produced in treatment T₈ when grafting performed on 30th October (T₈).

The number of leaves at 180 days, treatment T₄ (30th August) was significantly superior over all other treatments by producing maximum number of leaves

(23.33). It was followed by treatment T₃ (15th August) (22.47), T₂ (30th July) (19.27) and T₁ (15th July) (18.87). However minimum number of leaves per graft was observed in treatment T₈ (30th October) (13.07) followed by T₇ (15th October) (15.20), T₆ (30th September) (16.00) and T₅ (15th September) (17.13). Whereas treatment T₄ with T₃, T₂ with T₁ and treatments T₅, T₆ and T₇ were at par with each other in relation with number of leaves produced per graft.

Table 4.4 Number of branches at different growth stages

Treatments	No. of branches at different growth stages				
	At 60 days	At 90 days	At 120 days	At 150 days	At 180 days
T ₁ - 15 th July	1.47	1.90	2.20	2.40	2.47
T ₂ - 30 th July	1.53	2.07	2.33	2.53	2.60
T ₃ - 15 th August	1.67	2.20	2.47	3.07	3.40
T ₄ - 30 th August	2.13	2.60	2.73	3.34	3.80
T ₅ - 15 th September	1.33	1.73	1.80	2.13	2.33
T ₆ - 30 th September	1.20	1.57	1.67	2.07	2.27
T ₇ - 15 th October	1.13	1.33	1.47	1.80	1.93
T ₈ - 30 th October	1.07	1.13	1.17	1.53	1.80
S. E. (m) $\pm$	0.12	0.07	0.08	0.08	0.09
C. D. at 5%	0.37	0.23	0.27	0.26	0.27

Data regarding number of branches produced per grafts as influenced by time are presented in table 4.4 and graphically depicted in Fig. 4. The number of branches per graft at 60 days, 90 days, 120 days, 150 days and 180 days after grafting were found to be significantly influenced by time of soft wood grafting in jamun.

The number of branches per graft at 60 days after grafting, significantly maximum number of branches

(2.13) was obtained in the treatment T₄ (30th August). This treatment was found significantly superior over all other treatments which was followed by treatment T₃ (15th August) (1.67), T₂ (30th July) (1.53) and T₁ (15th July) (1.47). Minimum number of branches (1.07) was produced when grafting performed on 30th October (T₈). Treatment T₃, T₂ and T₁ were at par with each other as well as treatment T₅, T₆, T₇ and T₈ were also at par with each other in respect of branches produced per graft.

The number of branches produced at 90 days after grafting, treatment T₄ (30th August) produced significantly maximum number of branches (2.60) when soft wood grafting performed on 30th August. While minimum number of branches (1.13) was produced when soft wood grafting performed on 30th October (T₈).

The number of branches produced at 120 days after grafting, significantly maximum number of branches (2.73) produced when soft wood grafting performed on 30th August (T₄). However treatment T₄ is at par with treatments T₃, T₂ and T₁. From table 4.4 it is also observed that treatment T₄ onwards there was consistent and gradual decrease in number of branches per graft. Treatment T₈ produced minimum number of branches (1.17) when grafting was performed on 30th October (T₈). Treatment T₅ is at par with treatment T₆ and T₇.

Similarly, at 150 days after soft wood grafting, treatment T₄ (30th August) produced maximum number of branches (3.34) when grafting was performed on 30th

August, whereas minimum number of branches (1.53) was produced in the treatment T₈ (30th October).

In case of 180 days after grafting, the treatment T₄ was significantly superior over rest of treatments producing maximum number of branches (3.80) when grafting done on 30th August. The second best treatment was T₃ which produced (3.40) branches per graft. From treatment T₄ onwards there was gradual decrease in number of branches. Minimum number of branches (1.80) was produced by the treatment T₈ (30th October) followed by T₇ (15th October) (1.93). Treatment T₂ with T₁, T₅ with T₆ as well as T₇ is also at par with treatment T₈.

Table 4.5 Diameter of Scion (above one cm of graft union) (mm) at different growth stages

Treatments	Diameter of scion at different growth stages				
	At 60 days	At 90 days	At 120 days	At 150 days	At 180 days
T ₁ - 15 th July	11.03	11.15	11.27	11.37	11.45
T ₂ - 30 th July	11.13	11.20	11.30	11.40	11.48
T ₃ - 15 th August	11.41	11.43	11.50	11.55	11.62
T ₄ - 30 th August	11.60	11.68	11.80	12.00	12.10
T ₅ - 15 th September	10.98	11.08	11.20	11.27	11.37
T ₆ - 30 th September	10.83	10.90	10.97	11.07	11.13
T ₇ - 15 th October	10.76	10.87	10.93	11.00	11.10
T ₈ - 30 th October	10.70	10.73	10.83	10.93	11.03
S. E. (m) ±	0.05	0.06	0.06	0.06	0.06
C. D. at 5%	0.15	0.18	0.20	0.18	0.18

The data regarding diameter of scion of grafts as influenced by different time of soft wood grafting are shown in table 4.5 and graphically depicted in Fig. 5.

The diameter of scion per graft at 60 days, 90 days, 120 days, 150 days and 180 days after grafting were found to be significantly influenced by time of soft wood grafting in jamun.

The diameter of scion per graft at 60 days after grafting, significantly maximum diameter of scion (11.60 mm) was obtained in the treatment of 30th August (T₄) which was followed by grafting performed on 15th August (T₃) (11.41 mm), 30th July (T₂) (11.13 mm) and 15th July (T₁) (11.03) while minimum diameter of scion (10.70 mm) was recorded in grafting done on 30th October (T₈). However, treatments T₂, T₁, T₅, T₆, T₇ and T₈ were at par with each other.

Treatment T₄ (30th August) showed maximum diameter of scion (11.68 mm) while minimum diameter of scion (10.73 mm) was observed in the treatment T₈ (30th October) at 90 days after grafting.

The diameter of scion at 120 days, treatment T₄ was significantly superior to rest of the treatments when grafting practiced on 30th August (11.80 mm). Treatment T₃ (15th August) (11.50 mm) followed by T₂ (30th July) (11.30 mm) and T₁ (15th July) (11.27 mm). Minimum diameter of scion (10.83 mm) was obtained when soft wood grafting done on 30th October (T₈) which was statistically inferior. Treatments T₃, T₂, T₁ as well as T₆, T₇ and T₈ were at par with each other.

Similarly at 150 days after grafting, maximum diameter of scion (12.00 mm) was observed in treatment T₄ (30th August) while minimum diameter of scion (10.93 mm) in treatment T₈ (30th October).

In case of 180 days after soft wood grafting, treatment T₄ is significantly superior over rest of the treatments having maximum diameter of scion (12.10 mm) when grafting performed on 30th August. From treatment T₄ onwards there was consistent minimum diameter of graft scion. Treatment T₈ had recorded minimum diameter of graft union (11.03 mm) when grafting practiced on 30th October. While treatment T₅ (15th September) (11.37 mm) followed by T₆ (30th September) (11.13 mm) and T₇ (15th October) (11.10 mm). Treatments T₃, T₂, T₁ as well as T₆, T₇ and T₈ were at par with each other.

Table 4.6 Diameter of rootstock (below one cm of graft union) (mm) at different growth stages

Treatments	Diameter of rootstock at different growth stages				
	At 60 days	At 90 days	At 120 days	At 150 days	At 180 days
T ₁ - 15 th July	10.86	10.98	11.13	11.28	11.38
T ₂ - 30 th July	10.96	11.03	11.20	11.31	11.43
T ₃ - 15 th August	11.23	11.30	11.41	11.46	11.55
T ₄ - 30 th August	11.43	11.51	11.63	11.83	11.88
T ₅ - 15 th September	10.83	10.93	11.03	11.16	11.23
T ₆ - 30 th September	10.73	10.78	10.85	10.96	11.03
T ₇ - 15 th October	10.66	10.70	10.76	10.90	10.98
T ₈ - 30 th October	10.56	10.63	10.71	10.86	10.96
S. E. (m) ±	0.05	0.07	0.06	0.05	0.05
C. D. at 5%	0.15	0.23	0.19	0.18	0.17

Data regarding diameter of rootstock per grafts as influenced by time are presented in table 4.6 and graphically depicted in Fig. 6. The diameter of rootstock per graft at 60 days, 90 days, 120 days, 150 days and 180 days after grafting were found to be significantly influenced by time of soft wood grafting in jamun at different timing.

The diameter of rootstock at 60 days after grafting, obtained maximum (11.43 mm) in treatment T₄ which was grafted on 30th August. This treatment was found significantly superior over all other treatments which was followed by treatment T₃ (15th August) (11.23 mm), T₂ (30th July) (10.96 mm,) and T₁ (15th July) (10.86 mm). Minimum diameter of rootstock (10.56 mm) was produced when grafting performed on 30th October (T₈). Treatments T₂, T₁, T₅, T₆, T₇ and T₈ were at par with each other.

The diameter of rootstock at 90 days after grafting, recorded maximum diameter of rootstock (11.51 mm) in treatment T₄ (30th August) while minimum diameter of rootstock (10.63 mm) was recorded in treatment T₈ (30th October).

The diameter of rootstock at 120 days after grafting, treatment T₄ was significantly superior to rest of the treatments when grafting practiced on 30th August (11.63 mm). Treatment T₃ (15th August) (11.41 mm) followed by T₂ (30th July) (11.20 mm) and T₁ (15th July) (11.13 mm). Minimum diameter of scion (10.71 mm) was obtained when soft wood grafting done on 30th October (T₈) which was statistically inferior. Treatments T₂, T₁, T₅, T₆, T₇ and T₈ were at par with each other.

Similarly, 150 days after grafting maximum diameter of rootstock (11.83 mm) was recorded in treatment T₄ (30th August) while minimum diameter of rootstock (10.86 mm) in treatment T₈ (30th October).

In case of 180 days after soft wood grafting, treatment T₄ is significantly superior over rest of the treatments having maximum diameter of rootstock (11.88 mm) when grafting performed on 30th August. From treatment T₄ onwards there was consistent minimum diameter of rootstock. Treatment T₈ had recorded minimum diameter of rootstock (10.96 mm) when grafting practiced on 30th October. Whereas treatment T₅ (15th September) (11.23 mm) followed by T₆ (30th September) (11.03 mm) and T₇ (15th October) (10.98 mm). Treatment T₃, T₂, T₁, T₅ as well as T₆, T₇ and T₈ were at par with each other.

Table 4.7 Number of internodes at different growth stages

Treatments	No. of internodes at different growth stages				
	At 60 days	At 90 days	At 120 days	At 150 days	At 180 days
T ₁ - 15 th July	3.00	4.60	6.13	7.37	9.70
T ₂ - 30 th July	3.47	4.87	6.93	7.53	10.53
T ₃ - 15 th August	4.60	6.43	7.87	8.47	11.63
T ₄ - 30 th August	5.13	6.60	8.93	10.53	12.53
T ₅ - 15 th September	2.60	4.40	6.00	7.33	8.93
T ₆ - 30 th September	2.33	3.93	5.60	7.23	8.60
T ₇ - 15 th October	2.20	3.40	5.33	6.87	7.76
T ₈ - 30 th October	2.00	2.60	4.47	6.17	6.60
S. E. (m) $\pm$	0.14	0.16	0.18	0.47	0.11
C. D. at 5%	0.43	0.51	0.55	1.14	0.34

The data regarding number of internodes per grafts as influenced by time of grafting are depicted in table 4.7 and graphically shown in Fig. 7.

Number of internodes per graft at 60 days, 90 days, 120 days, 150 days and 180 days after soft wood grafting was found significant and influenced by different time of soft wood grafting.

Treatment T₄ (30th August) was significantly superior when soft wood grafting was practiced on 30th August by producing maximum number of internodes (5.13) at 60 days after grafting. It was followed by 15th August (T₃) (4.60), 30th July (T₂) (3.47) and 15th July (T₁) (3.00). Minimum number of internodes (2.00) was recorded when grafting performed on 30th October (T₈). The treatments T₁, T₅, T₆, T₇ and T₈ were at par with each other.

Number of internodes at 90 days after grafting, treatment T₄ (30th August) was produced maximum number of internodes (6.60) whereas minimum number of internodes (2.60) was produced when grafting was performed on 30th October (T₈).

The number of internodes at 120 days after grafting, the treatment T₄ (30th August) was significantly superior over rest of the treatments and produced maximum number of internodes (8.93). It was followed by T₃ (15th August) (7.87), T₂ (30th July) (6.93) and T₁ (15th July) (6.13) regards to internodes per graft. The minimum number of internodes was recorded by T₈ (4.47) when grafts performed on 30th October. Whereas treatments T₁, T₅, T₆ and T₇ were at par with each other.

Perusal of data recorded on 150 days after soft wood grafting in jamun, treatment T₄ (30th August) produced maximum number of internodes (10.53) whereas minimum number of internodes (6.17) produced in treatment T₈ when soft wood grafting was performed on 30th October.

In case of number of internodes at 180 days after soft wood grafting, the treatment T₄ (30th August) was significantly superior over rest of all the treatments and produced maximum number of internodes (12.53). It was followed by T₃ (15th August) (11.63), T₂ (30th July) (10.53) and T₁ (15th July) (9.70). The minimum (6.60) numbers of internodes were recorded when grafting done on 30th October (T₈). Treatment T₅ (15th September) (8.93) followed by T₆ (30th September) (8.60) and T₇ (15th October) (7.76). Treatment T₅ and T₆ were at par with each other.

Table 4.8 Length of internodes (cm) at different growth stages

Treatments	Length of internodes at different growth stages				
	At 60 days	At 90 days	At 120 days	At 150 days	At 180 days
T ₁ - 15 th July	0.71	0.93	1.33	1.66	1.95
T ₂ - 30 th July	0.77	1.15	1.51	1.99	2.31
T ₃ - 15 th August	1.22	1.68	1.93	2.38	2.43
T ₄ - 30 th August	1.31	1.70	2.09	2.58	2.73
T ₅ - 15 th September	0.59	0.92	1.27	1.60	1.81
T ₆ - 30 th September	0.54	0.81	1.05	1.35	1.55
T ₇ - 15 th October	0.53	0.75	0.97	1.23	1.38
T ₈ - 30 th October	0.47	0.64	0.88	1.09	1.23
S. E. (m) $\pm$	0.01	0.01	0.02	0.02	0.03
C. D. at 5%	0.05	0.05	0.07	0.08	0.08

Data regarding length of internodes per grafts as influenced by time of grafting are shown in table 4.8 and graphically presented in Fig. 8. Length of internodes per graft at 60 days, 90 days, 120 days, 150 days and 180 days after soft wood grafting was revealed significantly influenced by different time of grafting.

The length of internodes at 60 days, treatment T₄ (30th August) was significantly superior when grafting practiced on 30th August, produced maximum length of internodes (1.31 cm). It was followed by T₃ (15th August) (1.22 cm), T₂ (30th July) (0.77 cm) and T₁ (15th July) (0.71 cm). Minimum length of internodes (0.47 cm) was recorded by T₈ when soft wood grafting done on 30th October. Whereas treatment T₂ was at par with treatment T₁ as well

as treatment T₅, T₆ and T₇ were at par with each other for length of internodes at 60 days after grafting.

The length of internodes at 90 days, treatment T₄ (30th August) was produced highest length of internodes (1.70 cm) while minimum length of internodes (0.64 cm) produced in treatment T₈ when grafting performed on 30th October.

The treatment T₄ (30th August) was significantly superior over rest of the treatments and produced maximum length of internodes (2.09 cm) at 120 days after grafting. It was followed by T₃ (15th August) (1.93 cm), T₂ (30th July) (1.51 cm) and T₁ (15th July) (1.33 cm) internodes per graft. The minimum length of internodes was recorded in treatment T₈ when soft wood grafting done on 30th October. Treatment T₁ and T₅ were at par with each other.

Similarly trend was observed at 150 days after grafting, maximum length of internodes (2.58 cm) was produced in treatment T₄ (30th August) while minimum length of internodes (1.09 cm) was produced in treatment T₈ (30th October).

All treatments pertaining to length of internodes at 180 days after grafting showed significant variation. Whereas length of internodes at 180 days after grafting, the treatment T₄ (30th August) was significantly superior over rest of all the treatments and produced maximum length of internodes (2.73 cm). It was followed by T₃ (15th August) (2.43 cm), T₂ (30th July) (2.31 cm) and T₁ (15th days) (1.95 cm). Minimum (1.23 cm) numbers of internodes were recorded when grafting done on 30th October (T₈). However

treatment T₅ (15th September) (1.81 cm) followed by T₆ (30th September) (1.55 cm) and T₇ (15th October) (1.38 cm).

Table 4.9 Survival percentage over success of grafts (%) at different growth stages

Treatments	Survival percentage over success of grafts at different growth stages (%)				
	At 60 days	At 90 days	At 120 days	At 150 days	At 180 Days
T ₁ - 15 th July	90.24	80.49	78.04	70.73	60.97
T ₂ - 30 th July	92.86	88.10	80.95	71.42	66.66
T ₃ - 15 th August	95.56	88.89	82.22	73.33	68.88
T ₄ - 30 th August	97.87	93.62	89.36	80.85	76.59
T ₅ - 15 th September	89.47	78.95	73.68	65.78	57.89
T ₆ - 30 th September	88.57	77.14	71.42	62.85	54.28
T ₇ - 15 th October	87.50	75.00	68.75	59.37	46.87
T ₈ - 30 th October	86.67	73.33	66.66	56.66	43.33
S. E. (m) $\pm$	0.62	0.57	0.67	0.59	0.42
C. D. at 5%	1.89	1.75	2.03	1.81	1.30

Data of survival percentage over success of grafts was influenced by different treatments of grafting time are depicted in table 4.9 and graphically presented in Fig. 9. The survival percentage over success of graft at 60 days, 90 days, 120 days, 150 days and 180 days was significantly influenced by different grafting time in jamun. The survival percentage over success of grafts at different junctures after soft wood grafting in jamun was calculated by considering survival per cent at 30 days (Table 4.1) as 100%. It is also noticed that all treatments of grafting performed at different time from July to October in jamun

were significantly different from each other at 60, 90, 120, 150 and 180 days after grafting.

The survival percentage over success of grafts at 60 days was recorded maximum (97.87%) when grafting performed on 30th August (T₄) which was significantly superior. Which was followed by soft wood grafting performed on 15th August (T₃) (95.56%), 30 July (T₂) (92.86%) and 15th July (T₁) (90.24%). Minimum survival percentage of grafts (86.67%) was recorded when grafting performed on 30th October (T₈). From table 4.8 it is revealed that, all the treatments were differed significantly.

The survival percentage over success of grafts at 90 days was maximum (93.62%) when grafting performed on 30th August (T₄). It was followed by grafting performed on 15th August (T₃) (88.89%), 30th July (T₂) (88.10%) and 15th July (T₁) (80.49%). The survival percentage of grafts was recorded minimum (73.33%) when grafting done on 30th October (T₈). Treatment T₃ and T₂ as well as treatment T₁ and T₅ are at par.

The survival percentage over success of grafts at 120 days was found maximum (89.36%) when grafting performed on 30th August (T₄). It was followed by grafting performed on 15th August (T₃) (82.22%), 30th July (T₂) (80.95%) and 15th July (T₁) (78.04%). The minimum survival percentage over success of grafts (66.66%) was observed when grafts done on 30th October (T₈). Treatment T₃ and T₂ are at par.

When soft wood grafting in jamun performed on 30th August (T₄) which has recorded highest (80.85%)

survival percentage over success of grafts at 150 days after grafting. This treatment was significantly superior over rest of the treatments followed by grafts performed on 15th August (T₃) (73.33%), 30th July (T₂) (71.42%) and 15th July (T₁) (70.73%). The minimum survival percentage over success of grafts (56.66%) was found when grafts performed on 30th October (T₈). Treatment T₂ and T₁ were at par with each other.

Survival percentage over success of grafts at 180 days i.e. final survival was recorded maximum (76.59%) when grafting performed on 30th August (T₄). It was significantly superior over rest of the treatments which was followed by grafts performed on 15th August (T₃) (68.88%), 30th July (T₂) (66.66%) and 15th July (T₁) (60.97%). From the treatment T₄ onwards there was consistent and gradual decrease in survival percentage of grafts. However minimum survival percentage (43.33%) was recorded when grafting performed on 30th October (T₈).

As regard of final survival percentage, when grafts were prepared on 30th August which indicates 2nd fortnight of August is most appropriate for grafting followed by 15th August (1st fortnight of August), July, September and October.

5. DISCUSSION

Present experiment entitled, “Standardization of grafting time in jamun (*Syzygium cumini* L.) under North Maharashtra conditions” was undertaken during July, 2012 to October, 2012 by using soft wood grafting method of propagation. Data obtained in respect of days required for sprouting, per cent success at 30 days, number of leaves, number of branches, diameter of graft union, number of internodes, length of internodes and survival percentage over success of grafts has been presented in the preceding chapter. These results are discussed here under appropriate subheadings.

Jamun (*Syzygium cumini* L.) is mostly propagated by the seed but since it does not come true to type by seed, it is advisable to multiply through vegetative means to avoid variations. In the recent years various methods and techniques of propagation in jamun have been gaining importance.

For successful plant propagation, the knowledge of different techniques of propagation, structure and growth of plant is highly essential. Besides there should be high technique skill of mechanical manipulation in various methods of plant propagation.

Success of budding or grafting operation is influenced by several factors, viz., physiological condition of stock and scion, hormonal balance of stock and scion, sap flowing condition at various stages of plant growth viz., dormancy period, new flush emergence. Blossom bud

differentiation and flowering also influence the success of budding or grafting operation, In addition to internal factors of plants growth, the climatic factors mainly temperature and humidity plays significant role. Prevailing maximum and minimum temperature ranging from 12.1°C to 32°C depending upon species are conducive to rapid growth (cell activity) (Hartmen and Kester, 1986).

Outdoor budding and grafting is done at a time of year when such favourable temperatures and humidity are expected and when the plant tissues especially the cambium are in a naturally active stages of growth.

5.1 Days required for sprouting

The perusal of data presented in table 4.1 revealed that, days required for sprouting differed significantly due to different time of grafting. The sprouting of jamun grafts performed on 30th August (T₄) showed early sprouting i.e. 16.20 days, followed by July, September and October months.

These results are in close conformity with Patil (2004) as mid-August wedge grafting initiated the earliest sprouts with maximum success followed by July.

The number of days for sprouting was recorded minimum (15.5) in July and August as compared to September and October (22.75) as explained by Singh and Singh (2006).

Early sprouting of the grafts might be due to favourable atmospheric conditions during that period especially optimum temperature coupled with proportionate humidity as experienced by Palande (2001).

It may also attributed due to the effect of high temperature which was helped in early sprouting because of fast establishment of vascular connection with rootstock and scion which has been also reported by Awasthi and Shukla (2003).

Similar results were obtained by Chovatia and Singh (2000). Such a wide variation in sprouting may passively be attributed due to wide variation in temperature and relative humidity during the period of investigation.

Jamun grafts performed on 30th October (T₈) taken highest number of days (24.60) for sprouting. The month of grafting influenced significantly and early sprouting was observed in August. Whereas in the month of October for sprouting might be due to lower relative humidity and high temperature which are determining factors for success of grafts.

5.2 Per cent success at 30 days

Data depicted in table 4.2 revealed that highest per cent success of grafts was recorded when grafted on 30th August in treatment T₄ at 30 days (78.33%). However minimum per cent success (50.00%) at 30 days of grafts performed on 30th October (T₈).

These results are in close agreement with Singh and Singh (2006) who reported that two years pooled data exhibited higher percentage of grafts success when soft wood grafting was done in the month of August (36%), closely followed in July.

These results of per cent success are also in agreement with the findings of Chovatia and Singh (2000),

and Singh *et al.* (2003) in jamun and lasoda respectively. Higher per cent success was recorded during August indicating the positive role of nitrogen and carbohydrate in union physiology of grafting. Better nutrient uptake and faster plant growth of scion due to congenial temperature and humidity conditions in August and July resulted in higher graft success.

Wide variation in sprouting and graft success may passively be attributed due to wide variation in temperature and relative humidity during the study. These factors influence the sprouting and graft success (Awasthi and Shukla, 2003).

Best results of graft success in August may be also contributed by optimum temperature and relative humidity prevailing during the period of study which has played important role in early contact of cambium layers of stock and scion resulting in early callus formation and initiation of subsequent growth. Minimum success of grafts probably due to adverse temperature prevailing at that time which caused poor callus formation resulting in low success.

5.3 Number of leaves

Data depicted in table 4.3 revealed that, among different timings of softwood grafting in jamun, maximum number of leaves per graft were recorded in the treatment T₄ (30th August) at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (10.40, 14.87, 18.53, 21.80 and 23.33 leaves respectively). Comparatively minimum number of leaves per graft were observed in treatment T₈ (30th

October) at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (4.40, 6.33, 9.60, 11.47 and 13.07 leaves respectively).

These results are in line with the results of Mulla *et al.* (2011) who reported that, significantly maximum number of leaves per graft (10.59) were recorded at 30 days after graft success as compared to grafts performed during the month of September and October (9.27 and 7.81 leaves respectively) under controlled condition in jamun.

The environmental condition for mist house grafts can be readily controlled, thereby permitting greater reliability of grafting (Hartman and Kester, 1986).

Maximum number of leaves during August, July and June months may be due to the early sprouting of buds giving quick growth in the form of more number of leaves as explained by Patil *et al.* (1983). This more number of leaves per graft may also attributed due to reserved food material (Carbohydrate, Nitrogen) is comparatively more in sufficiently mature scion shoots. The quick and strong union formation, better nutrient uptake and ample growing period might have caused for higher number of leaves per plant.

There is descending trend of production of leaves from 30th August onwards i.e. grafts performed on 15th September, 30th September, 15th October and 30th October (17.13, 16.00, 15.20 and 13.07 leaves respectively) at 180 days after grafting. This descending trend of production of number of leaves per grafts may be due to varied climatic condition coupled with lower relative humidity during this period of experiment.

5.4 Number of branches

Data depicted in table 4.4 revealed that softwood grafting performed on 30th August (T₄) exhibited maximum number of branches per graft at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (2.13, 2.60, 2.73, 3.34 and 3.80 branches respectively). However minimum number of branches per graft was observed in treatment T₈ (30th October) at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (1.07, 1.13, 1.17, 1.53 and 1.80 branches respectively).

More number of sprouted shoots in August month may be due to adequate supply of desired and healthy scion sticks coupled with warm humid climate as reported by Sawke *et al.* (1985).

5.5 Diameter of scion

Maximum diameter of scion was observed in T₄ when softwood grafting performed on 30th August at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (11.60, 11.68, 11.80, 12.00 and 12.10 mm diameter respectively).

However, minimum diameter of scion of grafted jamun plants was observed in treatment T₈ (30th October) at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (10.70, 10.73, 10.83, 10.93 and 11.03 mm diameter respectively). Similar results were reported by Sarade *et al.* (1991).

In the month of August grafting time, scion sticks were of better physiological condition *viz.*, sap flowing

condition, adequate flow of cell sap activated but not sprouted scion sticks.

Scion sticks gave maximum growth in the month of August grafted plants followed by September and October grafted plants of jamun, which may be due to consigned climatic conditions resulting in better sprouting of scions as explained by Sarade *et al.* (1991).

5.6 Diameter of rootstock

The observation on diameter of rootstock revealed that, maximum diameter of rootstock of plant was observed in treatment T₄ when soft wood grafting performed on 30th August at 60 days, 90 days, 120 days, 150 days and 180 days after grafting. (11.43, 11.51, 11.63, 11.83 and 11.88 mm respectively).

Minimum (10.56, 10.63, 10.71, 10.86 and 10.96 mm) diameter of rootstock of grafted plants was observed in treatment T₈ (30th October) at 60, 90, 120, 150 and 180 days after grafting.

Except numerical differences, there was no appreciable difference was found in the rootstock during the month of July, September and October softwood grafted plants.

5.7 Number of internodes

Perusal of table 4.7 showed significant variation for number of internodes to different grafting time during the period of study. Maximum number of internodes per graft was observed in treatment T₄ when soft wood grafting performed on 30th August at 60 days, 90 days, 120 days,

150 days and 180 days after grafting (5.13, 6.60, 8.93, 10.53 and 12.53 numbers of internodes respectively).

Whereas minimum number of internodes per graft was noticed in treatment T₈ (30th October) at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (2.00, 2.60, 4.47, 6.17 and 6.60 number of internodes respectively). These more number of leaves may be due to higher percentage of graft take and also vigorous growth of success of grafts. Quick and strong union formation, better nutrient uptake and growing period might be caused for higher plant growth.

5.8 Length of internodes

Data on length of internodes presented in table 4.8 indicated that maximum length of internodes per graft was recorded in treatment T₄ when soft wood grafting was performed on 30th August at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (1.31, 1.70, 2.09, 2.58 and 2.73 mm length of internodes respectively). Minimum length of internodes per graft was observed in treatment T₈ (30th October) at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (0.47, 0.64, 0.88, 1.09 and 1.23 mm length of internodes respectively).

The result was in close agreement of Ratan *et al.* (1987) who reported 8-10 cm length of scion showed maximum percentage of sprouting (63.12%) and higher survival percentage (55.00%).

The more length of internodes might be contributed due to highest success percentage of grafts, vigour of scion sticks and more number of leaves per grafts.

5.9 Survival percentage over success of grafts

The observations of table 4.9 for survival percentage over success of grafts revealed that, maximum survival percentage over success of grafts was recorded in treatment T₄ when softwood grafting performed on 30th August at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (97.87, 93.62, 89.36, 80.85 and 76.59 survival percentage, respectively).

However the minimum survival percentage over success of grafts was observed in treatment T₈ when soft wood grafting performed on 30th October at 60 days, 90 days, 120 days, 150 days and 180 days after grafting (86.67, 73.33, 66.66, 56.66 and 43.33 survival percentage, respectively).

These results are in close conformation of those Patel and Amin (1981) who revealed soft wood grafting in situ more than 85 per cent success during the period from April to August. The results also showed that the period from October to November was not favourable for performing grafting in the western region of India.

Giri and Lenka (2007a) highest percentage of success was found in month of August (73.66%) followed by June (69%) and July (65%) in Tamarind.

These results are in close agreement of those of Giri and Lenka (2007b) highest percent success (92%) was observed in August followed by September (77%). Minimum per cent success was noticed in October (73.33%) when grafting was done in jamun.

Significant and highest survival of soft wood grafted plants seems to be due to meteorological factors

especially conducive temperature and high relative humidity which might have reduced the desiccation of tissues and facilitated faster cell division and proliferation of meristematic tissue at the cut surfaces of both the stock and scion leading to rapid and better union of graft components which reduced the mortality of sprouted grafts and increased the survival of softwood grafted plants.

To understand instantly, cumulative effect of weather parameters *viz.*, maximum temperature, minimum temperature and relative humidity (morning and evening) on success percentage of grafts jamun performed at different timing is presented graphically in Fig. 10.

6. SUMMARY AND CONCLUSION

Growing demand and importance for grafted plants of jamun needs rapid multiplication techniques with more success and survival of grafts under semi-arid region under North Maharashtra.

The present investigation entitled “Standardization of grafting time in jamun (*Syzygium cumini* L.) under North Maharashtra conditions” was carried out in Research Farm, Horticulture Section, College of Agriculture, Dhule during 2012-13. After performing grafting at different dates from July, 2012 to October, 2012 the response of jamun grafts to different months with 15 days interval was assessed in terms days required for sprouting, per cent success at 30 days, number of leaves, number of branches, diameter of graft union, number of internodes, length of internodes and survival percentage over success of grafts at 60, 90, 120, 150 and 180 days after soft wood grafting. There were 20 grafts in each replication for each treatment. In all total 8 treatments combination were assessed.

The results obtained of present study are briefly summarized and concluded here under appropriate subheads.

6.1 Summary

6.1.1 Days required for sprouting

Grafting done on 30th August (T₄) recorded significantly less number of days (16.20 days) was required

for sprouting. However, maximum days (24.60 days) were required for sprouting when grafts were performed on 30th October (T₈).

6.1.2 Per cent success at 30 days

As regard per cent success at 30 days, significantly maximum success (78.33%) of grafts was recorded when soft wood grafting performed on 30th August (T₄). Whereas minimum success of grafts (50.00%) was observed in treatment T₈ where softwood grafting performed on 30th October.

6.1.3 Number of leaves

Among growth observation when soft wood grafting practiced at different times, treatment T₄ (grafting done on 30th August) produced maximum number of leaves per graft (10.40, 14.87, 18.53, 21.80 and 23.33 leaves) at 60, 90, 120, 150 and 180 respectively. While, treatment T₈ (30th October) produced minimum number of leaves (4.40, 6.33, 9.60, 11.47 and 13.07 leaves) per graft was recorded at 60, 90, 120, 150 and 180 days after grafting.

6.1.4 Number of branches

Data pertaining to number of branches indicated that grafting done on 30th August (T₄) recorded maximum number of branches per graft (2.13, 2.60, 2.73, 3.34 and 3.80 branches) at 60, 90, 120, 150 and 180 days after grafting. However minimum number of branches (1.07, 1.13, 1.17, 1.53 and 1.80 branches) per graft was recorded

in treatment T₈ (30th October) at 60, 90, 120, 150 and 180 days after grafting.

6.1.5 Diameter of scion

Perusal of data diameter of scion showed that, maximum diameter of scion (11.60, 11.68, 11.80, 12.00 and 12.10 mm) was observed in treatment T₄ when soft wood grafting performed on 30th August per graft at 60, 90, 120, 150 and 180 days after grafting. Minimum diameter scion (10.70, 10.73, 10.83, 10.93 and 11.03 mm) per graft was observed in treatment T₈ at 60, 90, 120, 150 and 180 days after grafting.

6.1.6 Diameter of rootstock

Perusal of data diameter of rootstock showed that, maximum diameter of rootstock (11.43, 11.51, 11.63, 11.83, and 11.88 mm) was observed in treatment T₄ when soft wood grafting performed on 30th August per graft at 60, 90, 120, 150 and 180 days after grafting. Minimum diameter scion (10.56, 10.63, 10.71, 10.86 and 10.96 mm) per graft was observed in treatment T₈ at 60, 90, 120, 150 and 180 days after grafting.

6.1.7 Number of internodes

Grafts performed on 30th August (T₄) showed significantly maximum number of internodes (5.13, 6.60, 8.93, 10.53 and 12.53) per graft at 60, 90, 120, 150 and 180 days after grafting. Minimum numbers of internodes (2.00, 2.60, 4.47, 6.17 and 6.60) were recorded in

treatment T₈ when jamun plants grafted on 30th October at 60, 90, 120, 150 and 180 days after grafting.

6.1.8 Length of internodes

Significantly maximum length of internodes (1.31, 1.70, 2.09, 2.58 and 2.73 cm) was observed in treatment T₄ when soft wood grafting performed on 30th August at 60, 90, 120, 150 and 180 days after grafting. While minimum length of internodes (0.47, 0.64, 0.88, 1.09 and 1.23 cm) was recorded in treatment T₈ October at 60, 90, 120, 150 and 180 days after grafting.

6.1.9 Survival percentage over success of grafts

As regards survival percentage over success of grafts, maximum (97.87, 93.62, 89.36, 80.85 and 76.59%) survival percentage over per cent success of grafts at 60, 90, 120, 150 and 180 days after soft wood grafting was recorded in the treatment T₄ when grafting done on 30th August. However, minimum survival percentage (86.67, 73.33, 66.66, 56.66 and 43.33%) over success of grafts over per cent success at 30 days was recorded in the treatment T₈ when softwood grafting performed on 30th October at 60, 90, 120, 150 and 180 days after grafting.

Conclusion

The overall picture that emerges from the database of results to all observations studied practically and numerically it shows that, 2nd fortnight of August (when plants grafted on 30th August) is an appropriate time for soft wood wedge grafting in jamun on rootstock of local

cultivar having one year age followed by 1st fortnight of August (when plants grafted on 15th August).

Soft wood wedge grafting done during the 2nd fortnight of August (when plants grafted on 30th August) proved to be better for early sprouting and growth of jamun grafts followed by 1st fortnight of August (when plants grafted on 15th August).

Highest survival percentage of grafted plants of jamun was obtained when soft wood wedge grafting practiced on 30th August (T₄) (during 2nd fortnight of August) followed by grafting performed on 15th August (T₃) (during 1st fortnight of August) for multiplication of elite jamun plants.

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8. APPENDIX

Meteorological data on temperature, relative humidity and rainfall during the period of experiment i.e. July, 2012 to March, 2013 under shade net condition in Nursery, Horticulture section, College of Agriculture, Dhule was given below-

Month	Week	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
		Max ^m	Min ^m	Morning	Afternoon	
July, 2012	27	33	24.6	90	73	109
	28	31.4	24.6	90	74	60.8
	29	32.2	25.2	84	64	15
	30	30	25.3	79	68	9.3
	31	29.7	24.1	85	68	18.5
August	32	29.7	24.4	84	75	34.5
	33	30	24	85	65	31
	34	32.1	23.9	90	63	17.2
	35	31.6	24	94	77	47.2
September	36	30.5	24	90	72	27.4
	37	30.5	22.7	90	76	71.4
	38	32.2	22.2	84	57	12.7
	39	32.9	22.7	82	45	15.2
October	40	34.5	23.8	81	46	6.9
	41	35.4	21.7	74	27	0
	42	35	19.8	73	22	0
	43	34.2	19.5	69	30	0
	44	32.9	18.8	65	32	0
November	45	32	15.9	66	42	0
	46	31.7	15.7	72	41	0
	47	31	14	70	42	0
	48	32.2	14.5	76	48	0

December	49	32.6	16.3	79	34	0
	50	30.7	14.8	77	40	0
	51	30.6	13.9	83	49	0
	52	29.2	11.3	82	47	0
January, 2013	1	28.7	11.8	85	53	0
	2	28.6	10.6	77	60	0
	3	29.5	12.3	78	38	0
	4	27.4	13.4	82	51	0
	5	31.9	16.3	76	44	0
February	6	28.9	17	77	44	6.3
	7	31	16.8	83	47	0
	8	33.2	14.1	84	42	0
	9	34.9	14.1	75	40	0
March	10	37.6	16.1	65	42	0
	11	36.5	18.8	76	50	8.3
	12	37.8	19.3	53	22	0
	13	38	21.7	50	23	0
Total Rainfall						490.7

7. VITA

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MASTER OF SCIENCE

in

(FRUIT SCIENCE)

2013

Title of thesis : “Standardization of grafting time in jamun (Syzygium cumini L.) under North Maharashtra conditions”.

Major Field : Horticulture (Fruit Science)

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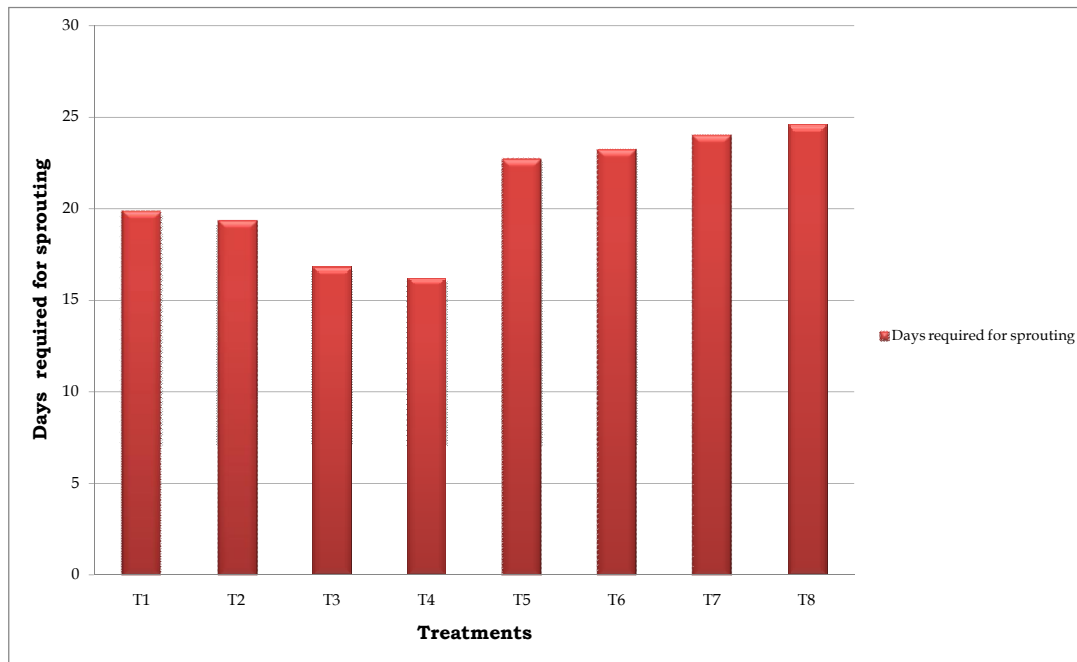


Fig.1 Days required for sprouting as influenced by grafting time

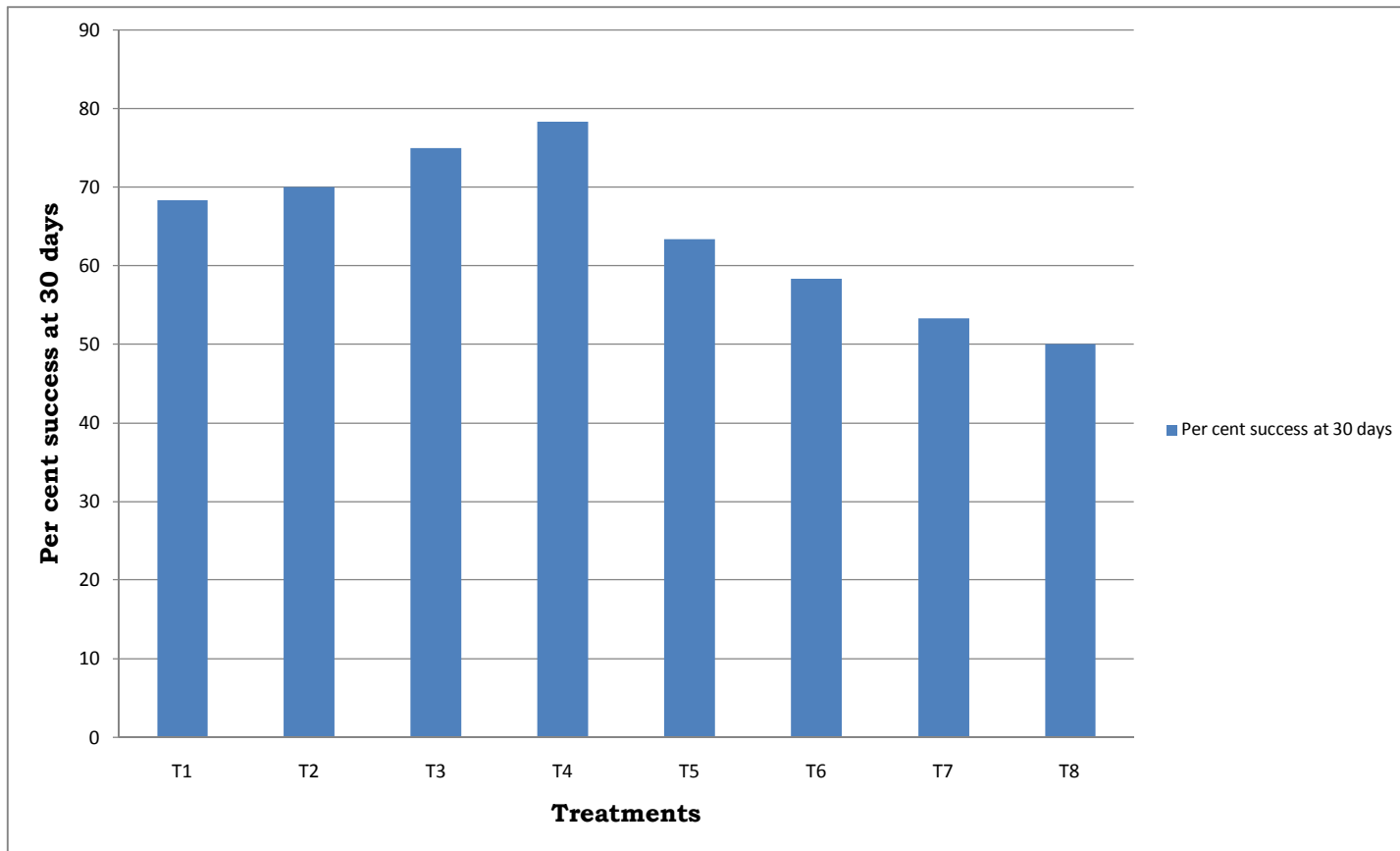


Fig.2 Per cent success at 30 days as influenced by grafting time

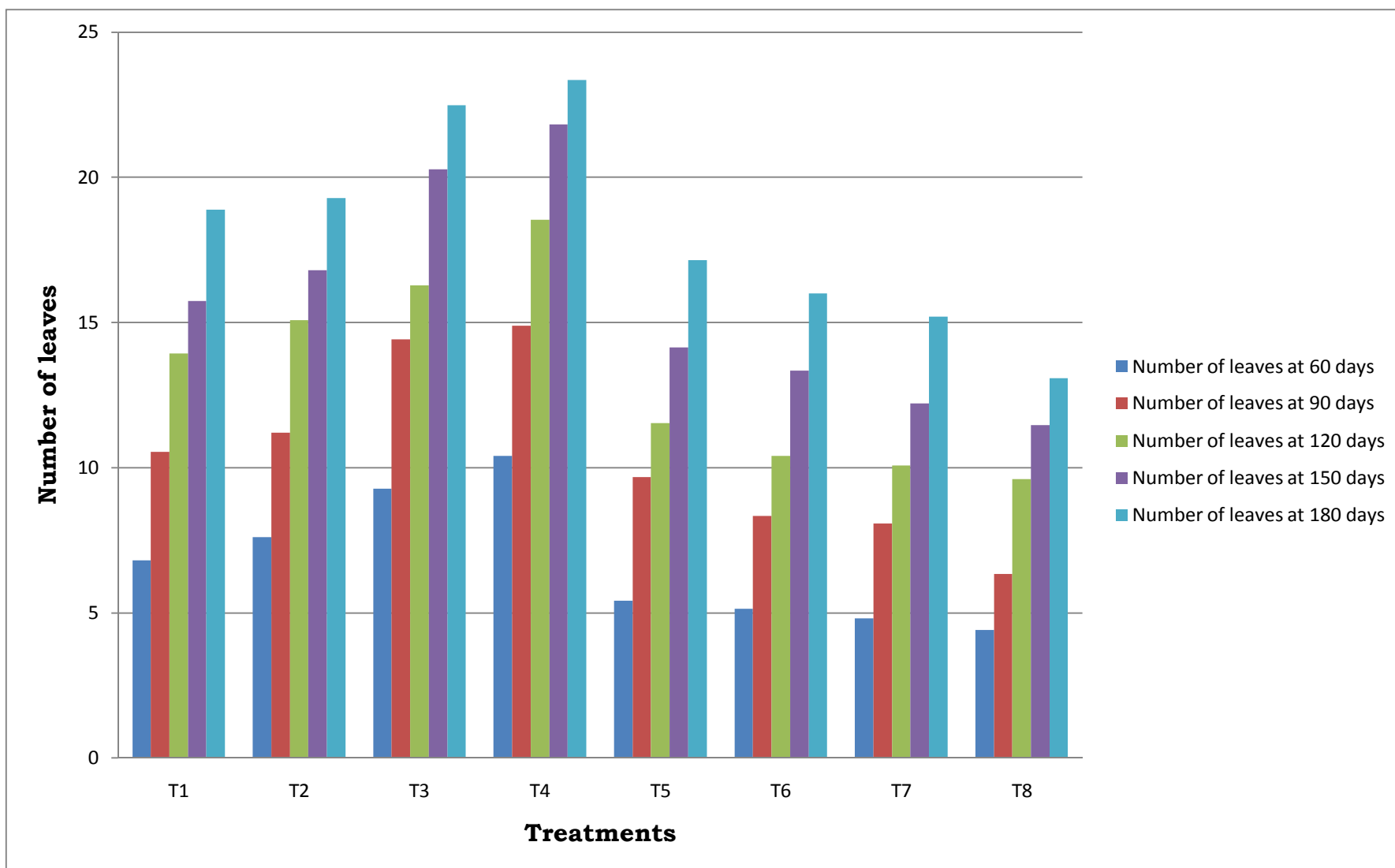


Fig.3 Number of leaves as influenced by grafting time at different growth stages

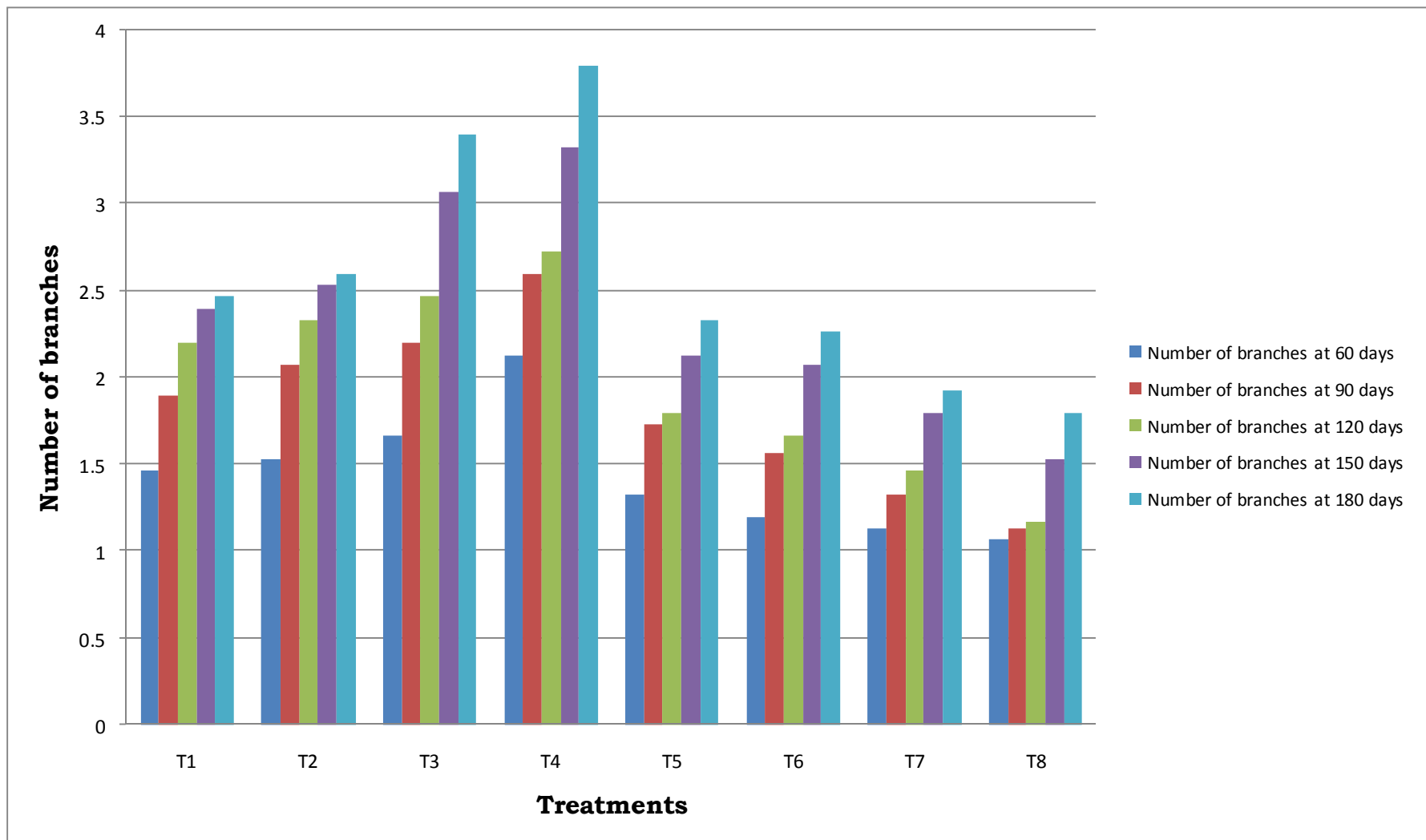


Fig.4 Number of branches as influenced by grafting time at different growth stages

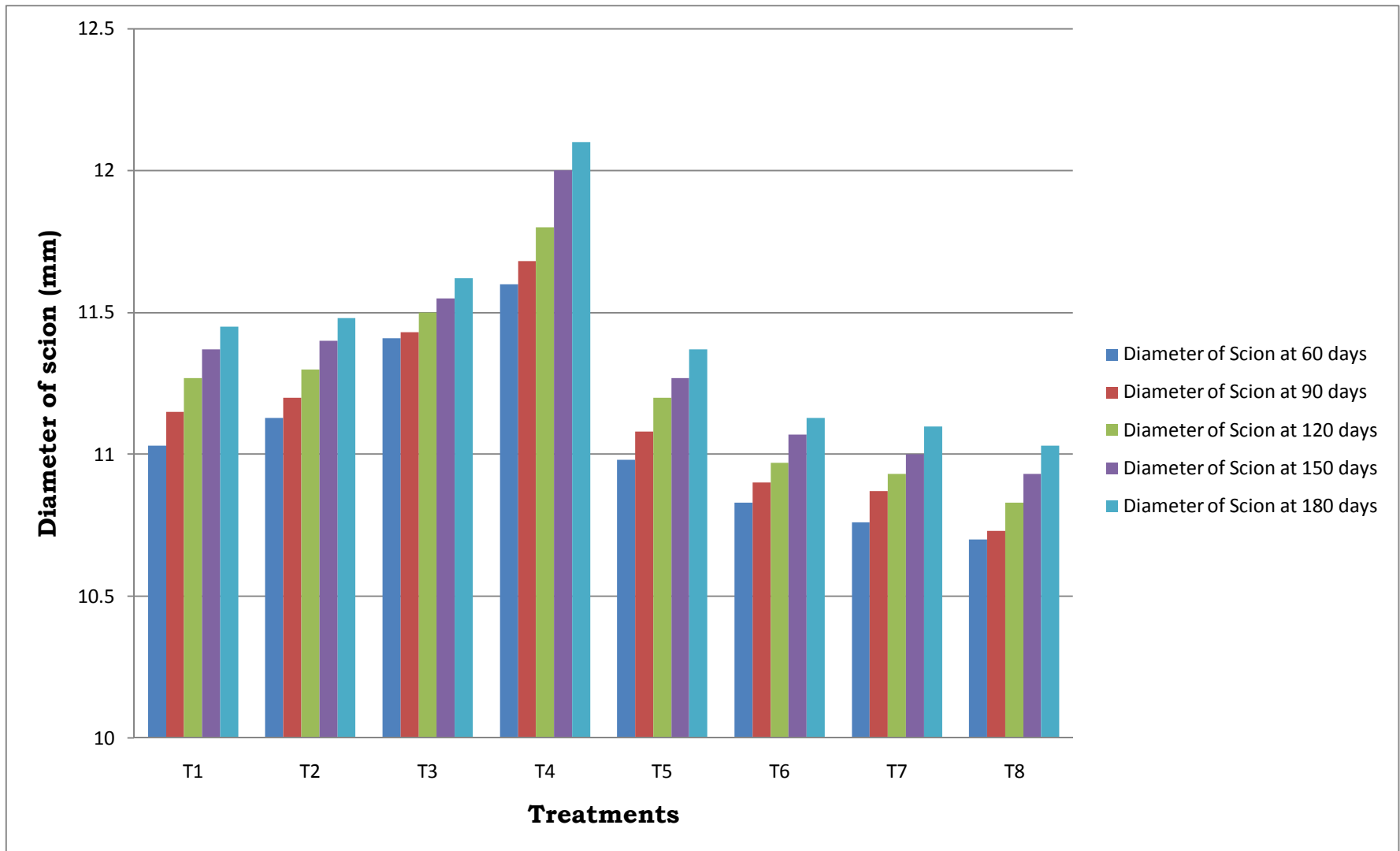


Fig. 5 Diameter of scion (One cm above graft union) (mm) as influenced by grafting time

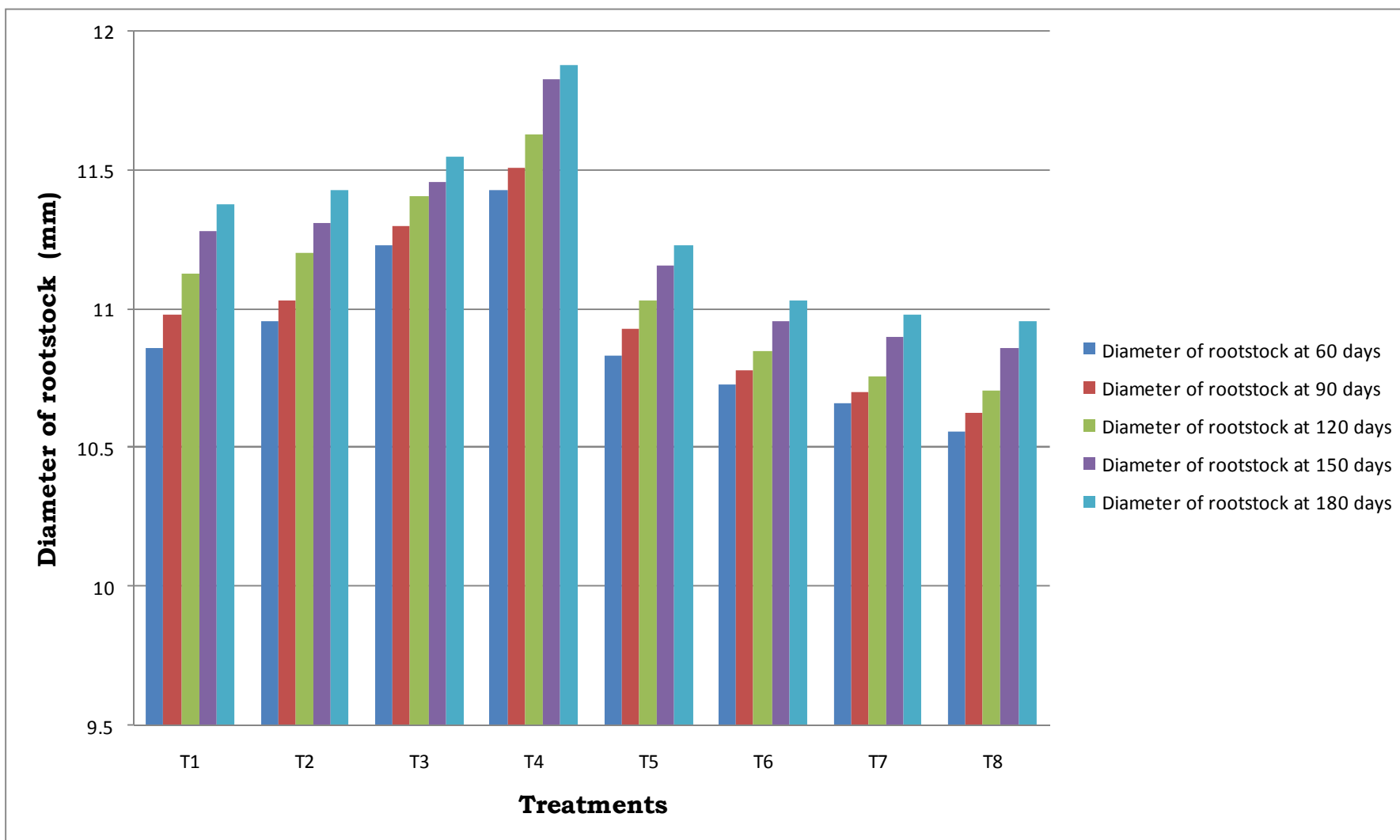


Fig. 6 Diameter of rootstock (One cm below graft union) (mm) as influenced by grafting time

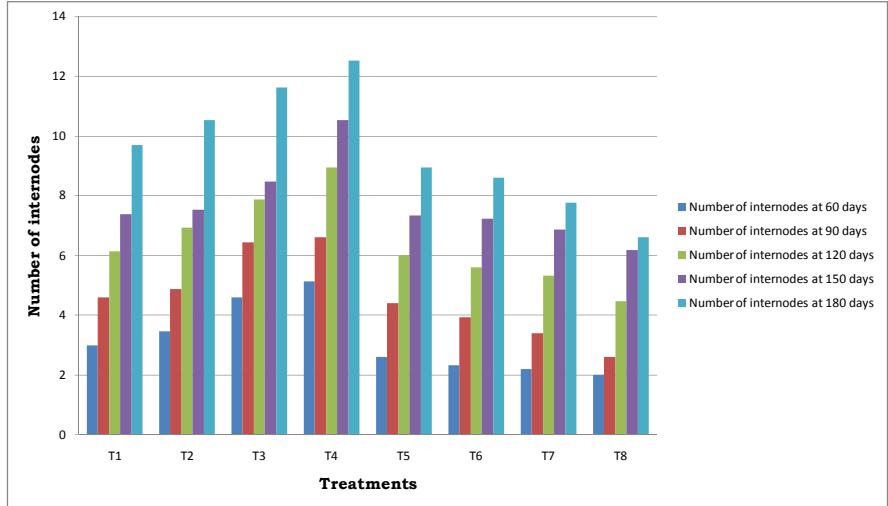


Fig. 7 Number of internodes as influenced by grafting time at different growth stages

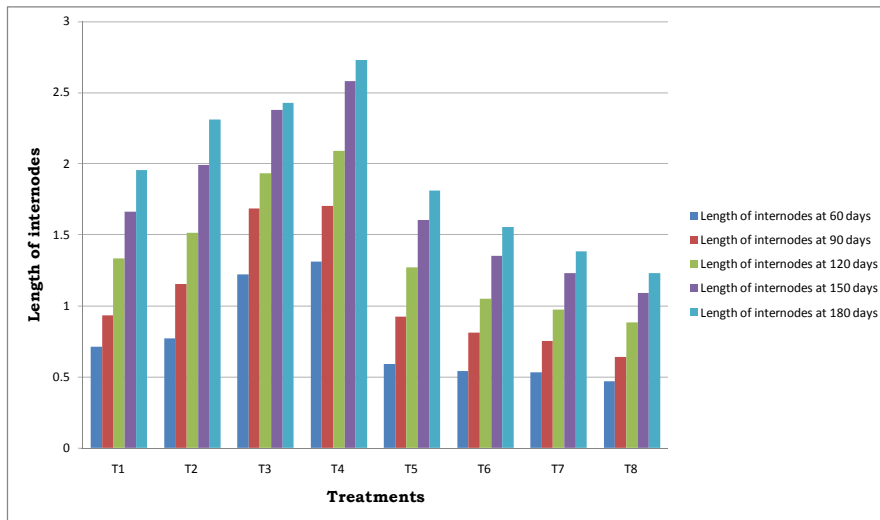


Fig. 8 Length of internodes (cm) as influenced by grafting time at different growth stages

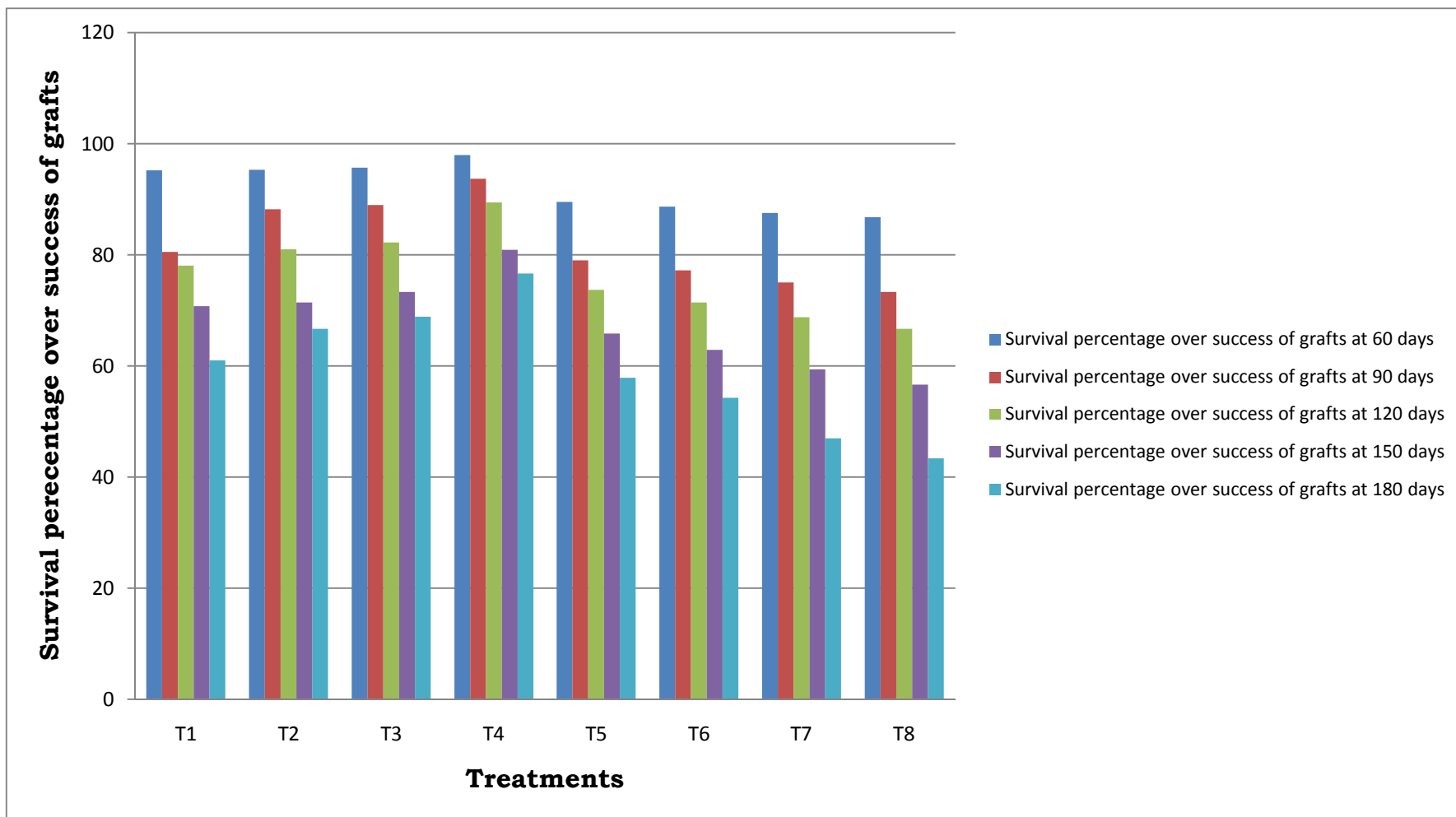


Fig. 9 Survival percentage over success of grafts as influenced by grafting time

Note: Survival percentage over success of grafts was calculated by considering per cent success at 30 days (Table 4.1) as 100%.

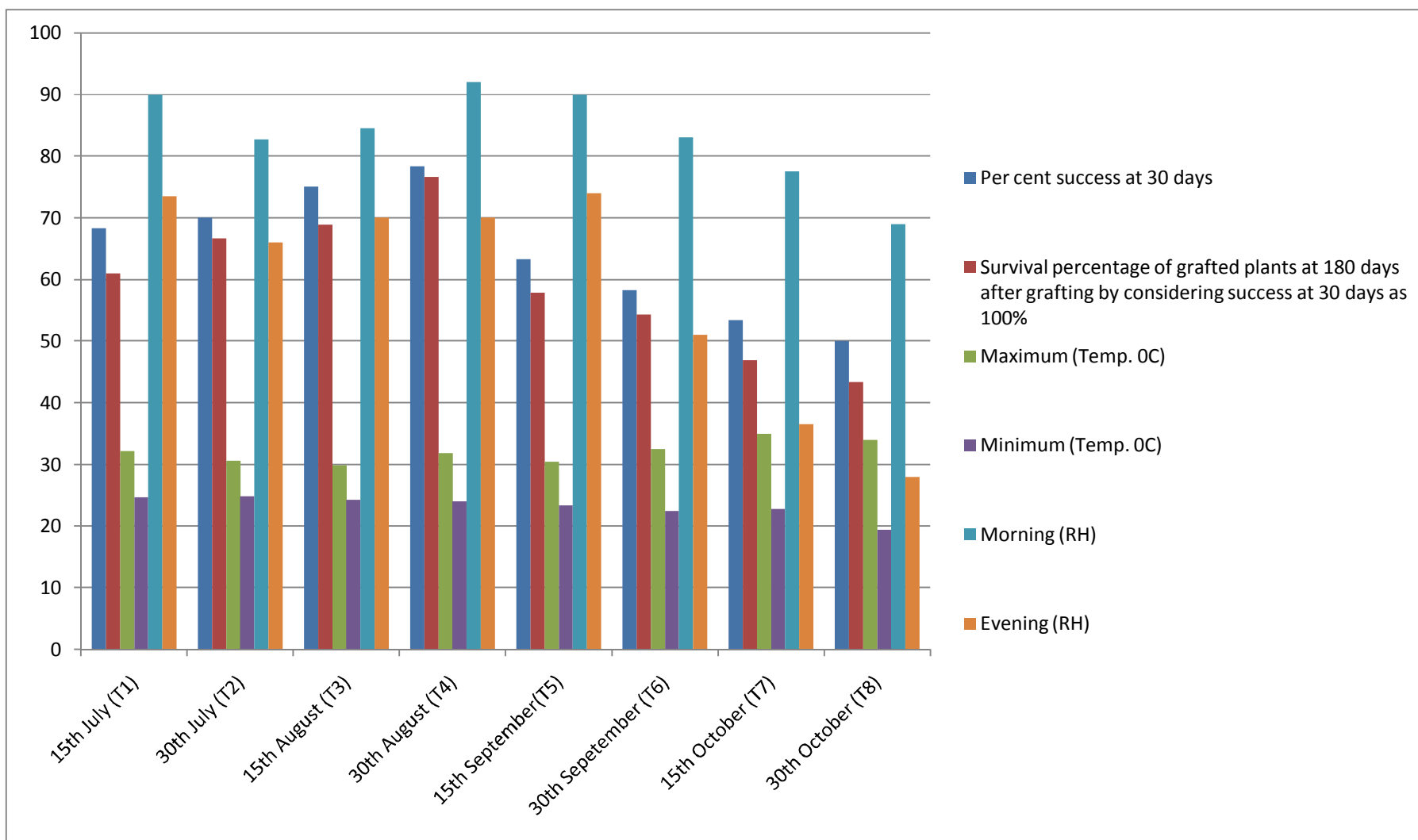


Fig. 10 Per cent success in softwood grafting at different timings as influenced by Weather parameters